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Best Demonstrated and Available Technology (BDAT) Background Document for K016, K019, K020, K030

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This background document provides the Agency's rationale and technical support for selecting the constituents to be regulated in K016, K018, K019, K020, and K030 wastes and for developing treatment standards for those regulated constituents. The document also provides waste characterization information that serves as a basis for determining whether a variance may be warranted for a particular waste having the same waste code as one of the five wastes above but with characteristics such that the particular waste is more difficult to treat than the waste for which the treatment standards have been established.

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FINAL

BEST DEMONSTRATED AND AVAILABLE TECHNOLOGY (BDAT)
BACKGROUND DOCUMENT FOR
K016, K018, K019, K020, K030

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EXECUTIVE SUMMARY

Pursuant to the Hazardous and Solid Waste Amendments (HSWA) enacted on November 8, 1984, the Environmental Protection Agency (EPA) is establishing best demonstrated available technology (BDAT) treatment standards for the listed wastes identified in 40 CFR 261.32 as K016, K018, K019, K020, and K030. Compliance with these BDAT treatment standards is a prerequisite for placement of these wastes in units designated as land disposal units according to 40 CFR Part 268. The BDAT treatment standards will be effective as of August 8, 1988.

This background document provides the Agency's rationale and technical support for selecting the constituents to be regulated in K016, K018, K019, K020, and K030 wastes and for developing treatment standards for those regulated constituents. The document also provides waste characterization information that serves as a basis for determining whether a variance may be warranted for a particular waste having the same waste code as one of the five wastes above but with characteristics such that the particular waste is more difficult to treat than the waste for which the treatment standards have been established.

The introductory section, which appears verbatim in all the First Third background documents, summarizes the Agency's legal authority and promulgated methodology for establishing treatment standards and discusses the petition process necessary for requesting a variance from the treatment standards. The remainder of the document presents waste-specific information--the number and locations of facilities affected by the land disposal restrictions for K016, K018, K019, K020, and K030 wastes; the waste-generating processes; characterization data; and the technologies used to treat the wastes (or similar wastes) and available performance data, including data on which the treatment standards are based. The document also explains EPA`s determination of BDAT, selection of constituents to be regulated, and calculation of treatment standards.

According to 40 CFR 261.32, waste codes K016, K018, K019, K020, and K030, which are generated by the organic chemicals industry, are listed as follows:

K016: Heavy ends or distillation residues from the production of carbon tetrachloride;

K018: Heavy ends from the fractionation column in ethyl chloride production;

K019: Heavy ends from the distillation of ethylene dichloride in ethylene dichloride production;

K020: Heavy ends from the distillation of vinyl chloride in vinyl chloride monomer production; and

K030: Column bottoms or heavy ends from the combined production of trichloroethylene and perchloroethylene.

The four digit Standard Industrial Classification (SIC) Code most often reported for the industry generating these wastes is 2869. The Agency estimates that there are approximately 47 facilities that may generate wastes identified as K016, K018, K019, K020, and K030.

The Agency is regulating a total of 24 organic constituents in K016, K018, K019, K020, and K030 nonwastewaters and wastewaters. (For the purpose of the land disposal restrictions rule, wastewaters are defined as wastes containing less than 1 percent (weight basis) total suspended solids* and less than 1 percent (weight basis) total organic carbon (TOC). Wastes not meeting this definition are classified as nonwastewaters.) Note that not all 24 constituents are being regulated in all five waste codes. The BDAT treatment standards for both nonwastewater and wastewater forms of K016, K018, K019, K020, and K030 wastes are based on performance data from rotary kiln incineration of K019 waste.

The following table lists the specific BDAT treatment standards for each of the five wastes. The treatment standards reflect the total concentration of constituents in nonwastewaters and wastewaters. The units for total constituent concentration are mg/kg (parts per million on a weight-by-weight basis) for the nonwastewaters and mg/l (parts per million on a weight-by-volume basis) for the wastewaters. If the concentrations of the regulated constituents in these wastes, as generated, are lower than or equal to the treatment standards, treatment is not required prior to land disposal.

Testing procedures for all sample analyses are specifically identified in Appendix D of this background document.

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*The term "total suspended solids" (TSS) clarifies EPA's previously used teminology of "total solids" and "filterable solids." Specifically, total suspended solids is measured by method 209C (Total suspended solids dried at 103-105°C) in Standard Methods for the Examination of Water and Wastewater, Sixteenth Edition.

BDAT TREATMENT STANDARDS FOR K016, K018, K019, K020, AND K030

	Maximum for any Single Grab Sample									
	Nonwastewater Total concentration (mg/kg)					Wastewater Total concentration (mg/l)				
	K016	K018	K019	K020	K030	K016	K018	K019	K020	K030
Chlorobenzene	NA	NA	6.0	NA	NA	NA	NA	0.006	NA	NA
Chloroethane	NA	6.0	NA	NA	NA	NA	0.007	NA	NA	NA
Chloroform	NA	NA	6.0	NA	NA	NA	NA	0.007	NA	NA
Chloromethane	NA	NA	NA	NA	NA	NA	0.007	NA	NA	NA
1,1-Dichloroethane	NA	6.0	NA	NA	NA	NA	0.007	NA	NA	NA
1,2-Dichloroethane	NA	6.0	6.0	6.0	NA	NA	0.007	0.007	0.007	NA
1,1,2,2-Tetrachloroethane	NA	NA	NA	5.6	NA	NA	NA	NA	0.007	NA
Tetrachloroethene	6.0	NA	6.0	6.0	6.0	0.007	NA	0.007	0.007	0.007
1,1,1-Trichloroethane	NA	6.0	6.0	NA	NA	NA	0.007	0.007	NA	NA
Bis(2-chloroethyl)ether	NA	NA	5.6	NA	NA	NA	NA	0.007	NA	NA
o-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.008
p-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	0.008	NA	0.008
Fluorene	NA	NA	NA	NA	NA	NA	NA	0.007	NA	NA
Hexachlorobenzene	28	28	NA	NA	NA	0.033	0.033	NA	NA	NA
Hexachlorobutadiene	5.6	5.6	NA	NA	5.6	0.007	0.007	NA	NA	0.007
Hexachlorocyclopentadiene	5.6	NA	NA	NA	NA	0.007	NA	NA	NA	NA
Hexachloroethane	28	28	28	NA	28	0.033	NA	0.033	NA	0.033
Hexachloropropene	NA	NA	NA	NA	19	NA	NA	NA	NA	NA
Naphthalene	NA	NA	5.6	NA	NA	NA	NA	0.007	NA	NA
Pentachlorobenzene	NA	NA	NA	NA	28	NA	NA	NA	NA	NA
Pentachloroethane	NA	5.6	NA	NA	5.6	NA	0.007	NA	NA	0.007
Phenanthrene	NA	NA	5.6	NA	NA	NA	NA	0.007	NA	NA
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	NA	14	NA	NA	0.017	NA	0.017
1,2,4-Trichlorobenzene	NA	NA	19	NA	19	NA	NA	0.023	NA	0.023

NA - Not applicable.

1.0 INTRODUCTION

This section of the background document presents a summary of the legal authority pursuant to which the BDAT treatment standards were developed, a summary of EPA's promulgated methodology for developing BDAT, and finally a discussion of the petition process that should be followed to request a variance from the BDAT treatment standards.

1.1 Legal Background

1.1.1 Requirements Under HSWA

The Hazardous and Solid Waste Amendments of 1984 (HSWA), which were enacted on November 8, 1984, and which amended the Resource Conservation and Recovery Act of 1976 (RCRA), impose substantial new responsibilities on those who handle hazardous waste. In particular, the amendments require the Agency to promulgate regulations that restrict the land disposal of untreated hazardous wastes. In its enactment of HSWA, Congress stated explicitly that "reliance on land disposal should be minimized or eliminated, and land disposal, particularly landfill and surface impoundment, should be the least favored method for managing hazardous wastes" (RCRA section 1002(b)(7), 42 U.S.C. 6901(b)(7)).

One part of the amendments specifies dates on which particular groups of untreated hazardous wastes will be prohibited from land disposal unless "it has been demonstrated to the Administrator, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous" (RCRA section 3004(d)(1), (e)(1), (g)(5), 42 U.S.C. 6924 (d)(1), (e)(1), (g)(5)).

For the purpose of the restrictions, HSWA defines land disposal "to include, but not be limited to, any placement of . . . hazardous waste in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave" (RCRA section 3004(k), 42 U.S.C. 6924(k)). Although HSWA defines land disposal to include injection wells, such disposal of solvents, dioxins, and certain other wastes, known as the California List wastes, is covered on a separate schedule (RCRA section 3004(f)(2), 42 U.S.C. 6924 (f)(2)). This schedule requires that EPA develop land disposal restrictions for deep well injection by August 8, 1988.

The amendments also require the Agency to set "levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized" (RCRA section 3004(m)(1), 42 U.S.C. 6924 (m)(1)). Wastes that meet treatment standards established by EPA are not prohibited and may be land disposed. In setting treatment standards for listed or characteristic wastes, EPA may establish different standards for particular wastes within a single waste code with differing treatability characteristics. One such characteristic is the physical form of the waste. This frequently leads to different standards for wastewaters and nonwastewaters.

Alternatively, EPA can establish a treatment standard that is applicable to more than one waste code when, in EPA's judgment, all the waste can be treated to the same concentration. In those instances where a generator can demonstrate that the standard promulgated for the generator's waste cannot be achieved, the Agency also can grant a variance from a treatment standard by revising the treatment standard for that particular waste through rulemaking procedures. (A further discussion of treatment variances is provided in Section 1.3.)

The land disposal restrictions are effective when promulgated unless the Administrator grants a national variance and establishes a different date (not to exceed 2 years beyond the statutory deadline) based on "the earliest date on which adequate alternative treatment, recovery, or disposal capacity which protects human health and the environment will be available" (RCRA section 3004(h)(2), 42 U.S.C. 6924 (h)(2)).

If EPA fails to set a treatment standard by the statutory deadline for any hazardous waste in the First Third or Second Third of the schedule (see Section 1.1.2), the waste may not be disposed in a landfill or surface impoundment unless the facility is in compliance with the minimum technological requirements specified in section 3004(o) of RCRA. In addition, prior to disposal, the generator must certify to the Administrator that the availability of treatment capacity has been investigated, and it has been determined that disposal in a landfill or surface impoundment is the only practical alternative to treatment currently available to the generator. This restriction on the use of landfills and surface impoundments applies until EPA sets a treatment standard for the waste or until May 8, 1990, whichever is sooner. If the Agency fails to set a treatment standard for any ranked hazardous waste by May 8, 1990, the waste is automatically prohibited from land disposal unless the waste is placed in a land disposal unit that is the subject of a successful "no migration" demonstration (RCRA section 3004(g), 42 U.S.C. 6924(g)). "No migration" demonstrations are based on case-specific petitions that show there will be no migration of hazardous constituents from the unit for as long as the waste remains hazardous.

1.1.2 Schedule for Developing Restrictions

Under section 3004(g) of RCRA, EPA was required to establish a schedule for developing treatment standards for all wastes that the Agency had listed as hazardous by November 8, 1984. Section 3004(g) required that this schedule consider the intrinsic hazards and volumes associated with each of these wastes. The statute required EPA to set treatment standards according to the following schedule:

1. Solvents and dioxins standards must be promulgated by November 8, 1986;

2. The "California List" must be promulgated by July 8, 1987;
3. At least one-third of all listed hazardous wastes must be promulgated by August 8, 1988 (First Third);
4. At least two-thirds of all listed hazardous wastes must be promulgated by June 8, 1989 (Second Third); and
5. All remaining listed hazardous wastes and all hazardous wastes identified as of November 8, 1984, by one or more of the characteristics defined in 40 CFR Part 261 must be promulgated by May 8, 1990 (Third Third).

The statute specifically identified the solvent wastes as those covered under waste codes F001, F002, F003, F004, and F005; it identified the dioxin-containing hazardous wastes as those covered under waste codes F020, F021, F022, and F023.

Wastes collectively known as the California List wastes, defined under section 3004(d) of HSWA, are liquid hazardous wastes containing metals, free cyanides, PCBs, corrosives (i.e., a pH less than or equal to 2.0), and any liquid or nonliquid hazardous waste containing halogenated organic compounds (HOCs) above 0.1 percent by weight. Rules for the California List were proposed on December 11, 1986, and final rules for PCBs, corrosives, and HOC-containing wastes were established August 12, 1987. In that rule, EPA elected not to establish standards for metals. Therefore, the statutory limits became effective.

On May 28, 1986, EPA published a final rule (51 FR 19300) that delineated the specific waste codes that would be addressed by the First

Third, Second Third, and Third Third. This schedule is incorporated into 40 CFR 268.10, 268.11, and 268.12.

1.2 Summary of Promulgated BDAT Methodology

In a November 7, 1986 rulemaking, EPA promulgated a technology-based approach to establishing treatment standards under section 3004(m). Section 3004(m) also specifies that treatment standards must "minimize" long- and short-term threats to human health and the environment arising from land disposal of hazardous wastes.

Congress indicated in the legislative history accompanying the HSWA that (t)he requisite levels of (sic) methods of treatment established by the Agency should be the best that has been demonstrated to be achievable," noting that the intent is "to require utilization of available technology" and not a "process which contemplates technology-forcing standards" (Vol. 130 Cong. Rec. S9178 (daily ed., July 25, 1984)). EPA has interpreted this legislative history as suggesting that Congress considered the requirement under section 3004(m) to be met by application of the best demonstrated and achievable (i.e., available) technology prior to land disposal of wastes or treatment residuals. Accordingly, EPA's treatment standards are generally based on the performance of the best demonstrated available technology (BDAT) identified for treatment of the hazardous constituents. This approach involves the identification of potential treatment systems, the determination of whether they are demonstrated and available, and the collection of treatment data from well-designed and well-operated systems.

The treatment standards, according to the statute, can represent levels or methods of treatment, if any, that substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents. Wherever possible, the Agency prefers to establish BDAT treatment standards as "levels" of treatment (i.e., performance standards), rather than adopting an approach that would require the use of specific treatment "methods." EPA believes that concentration-based treatment levels offer the regulated community greater flexibility to develop and implement compliance strategies, as well as an incentive to develop innovative technologies.

1.2.1 Waste Treatability Group

In developing the treatment standards, EPA first characterizes the waste(s). As necessary, EPA may establish treatability groups for wastes having similar physical and chemical properties. That is, if EPA believes that wastes represented by different waste codes could be treated to similar concentrations using identical technologies, the Agency combines the codes into one treatability group. EPA generally considers wastes to be similar when they are both generated from the same industry and from similar processing stages. In addition, EPA may combine two or more separate wastes into the same treatability group when data are available showing that the waste characteristics affecting performance are similar or that one waste would be expected to be less difficult to treat.

Once the treatability groups have been established, EPA collects and analyzes data on identified technologies used to treat the wastes in each treatability group. The technologies evaluated must be demonstrated on the waste or a similar waste and must be available for use.

1.2.2 Demonstrated and Available Treatment Technologies

Consistent with legislative history, EPA considers demonstrated technologies to be those that are used to treat the waste of interest or a similar waste with regard to parameters that affect treatment selection (see November 7, 1986, 51 FR 40588). EPA also will consider as treatment those technologies used to separate or otherwise process chemicals and other materials. Some of these technologies clearly are applicable to waste treatment, since the wastes are similar to raw materials processed in industrial applications.

For most of the waste treatability groups for which EPA will promulgate treatment standards, EPA will identify demonstrated technologies either through review of literature related to current waste treatment practices or on the basis of information provided by specific facilities currently treating the waste or similar wastes.

In cases where the Agency does not identify any facilities treating wastes represented by a particular waste treatability group, EPA may transfer a finding of demonstrated treatment. To do this, EPA will compare the parameters affecting treatment selection for the waste treatability group of interest to other wastes for which demonstrated technologies already have been determined. The parameters affecting treatment selection and their use for this waste are described in Section 3.2 of this document. If the parameters affecting treatment selection are similar, then the Agency will consider the treatment technology also to be demonstrated for the waste of interest. For example, EPA considers rotary kiln incineration to be a demonstrated technology for many waste codes containing hazardous organic constituents, high total organic content, and high filterable solids content, regardless of whether any facility is currently treating these wastes. The basis for this determination is data found in literature and data generated by EPA confirming the use of rotary kiln incineration on wastes having the above characteristics.

If no commercial treatment or recovery operations are identified for a waste or wastes with similar physical or chemical characteristics that affect treatment selection, the Agency will be unable to identify any demonstrated treatment technologies for the waste, and, accordingly, the waste will be prohibited from land disposal (unless handled in accordance with the exemption and variance provisions of the rule). The Agency is, however, committed to establishing treatment standards as soon as new or improved treatment processes are demonstrated (and available).

Operations only available at research facilities, pilot- and bench-scale operations, will not be considered in identifying demonstrated treatment technologies for a waste because these technologies would not necessarily be "demonstrated." Nevertheless, EPA may use data generated at research facilities in assessing the performance of demonstrated technologies.

As discussed earlier, Congress intended that technologies used to establish treatment standards under section 3004(m) be not only "demonstrated," but also available. To decide whether demonstrated technologies may be considered "available," the Agency determines whether they (1) are commercially available and (2) substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste.

EPA will only set treatment standards based on a technology that meets the above criteria. Thus, the decision to classify a technology as "unavailable" will have a direct impact on the treatment standard. If the best technology is unavailable, the treatment standard will be based on the next best treatment technology determined to be available. To the extent that the resulting treatment standards are less stringent, greater concentrations of hazardous constituents in the treatment residuals could be placed in land disposal units.

There also may be circumstances in which EPA concludes that for a given waste none of the demonstrated treatment technologies are "available" for purposes of establishing the 3004(m) treatment performance standards. Subsequently, these wastes will be prohibited from continued placement in or on the land unless managed in accordance with applicable exemptions and variance provisions. The Agency is, however, committed to establishing new treatment standards as soon as new or improved treatment processes become "available."

(1) Proprietary or Patented Processes. If the demonstrated treatment technology is a proprietary or patented process that is not generally available, EPA will not consider the technology in its determination of the treatment standards. EPA will consider proprietary or patented processes available if it determines that the treatment method can be purchased or licensed from the proprietor or is a commercially available treatment. The services of the commercial facility offering this technology often can be purchased even if the technology itself cannot be purchased.

(2) Substantial Treatment. To be considered "available," a demonstrated treatment technology must "substantially diminish the toxicity" of the waste or "substantially reduce the likelihood of migration of hazardous constituents" from the waste in accordance with section 3004(m). By requiring that substantial treatment be achieved in order to set a treatment standard, the statute ensures that all wastes are adequately treated before being placed in or on the land and ensures that the Agency does not require a treatment method that provides little or no environmental benefit. Treatment will always be deemed substantial if it results in nondetectable levels of the hazardous constituents of concern. If nondetectable levels are not achieved, then a determination of substantial treatment will be made on a case-by-case

basis. This approach is necessary because of the difficulty of establishing a meaningful guideline that can be applied broadly to the many wastes and technologies to be considered. EPA will consider the following factors in an effort to evaluate whether a technology provides substantial treatment on a case-by-case basis:

(a) Number and types of constituents treated;

(b) Performance (concentration of the constituents in the treatment residuals); and

(c) Percent of constituents removed.

If none of the demonstrated treatment technologies achieve substantial treatment of a waste, the Agency cannot establish treatment standards for the constituents of concern in that waste.

1.2.3 Collection of Performance Data

Performance data on the demonstrated available technologies are evaluated by the Agency to determine whether the data are representative of well-designed and well-operated treatment systems. Only data from well-designed and well-operated systems are included in determining BDAT. The data evaluation includes data already collected directly by EPA and/or data provided by industry. In those instances where additional data are needed to supplement existing information, EPA collects additional data through a sampling and analysis program. The principal elements of this data collection program are:

(1) Identification of facilities for site visits,
(2) Engineering site visit,
(3) Sampling and Analysis Plan,
(4) Sampling visit, and
(5) Onsite Engineering Report.

(1) Identification of Facilities for Site Visits. To identify facilities that generate and/or treat the waste of concern, EPA uses a number of information sources. These include Stanford Research Institute's Directory of Chemical Producers; EPA's Hazardous Waste Data Management System (HWDMS); the 1986 Treatment, Storage, Disposal Facility (TSDF) National Screening Survey; and EPA's Industry Studies Data Base. In addition, EPA contacts trade associations to inform them that the Agency is considering visits to facilities in their industry and to solicit their assistance in identifying facilities for EPA to consider in its treatment sampling program.

After identifying facilities that treat the waste, EPA uses this hierarchy to select sites for engineering visits:

(1) generators treating single wastes on site;
(2) generators treating multiple wastes together on site;
(3) commercial treatment, storage, and disposal facilities (TSDFs); and
(4) EPA in-house treatment.

This hierarchy is based on two concepts:

(1) to the extent possible, EPA should develop treatment standards from data produced by treatment facilities handling only a single waste, and

(2) facilities that routinely treat a specific waste have had the best opportunity to optimize design parameters. Although excellent treatment can occur at many facilities that are not high in this hierarchy, EPA has adopted this approach to avoid,

when possible, ambiguities related to the mixing of wastes before and during treatment.

When possible, the Agency will evaluate treatment technologies using commercially operated systems. If performance data from properly designed and operated commercial treatment methods for a particular waste or a waste judged to be similar are not available, EPA may use data from research facilities operations. Whenever research facility data are used, EPA will explain in the preamble and background document why such data were used and will request comments on the use of such data.

Although EPA's data bases provide information on treatment for individual wastes, the data bases rarely provide data that support the selection of one facility for sampling over another. In cases where several treatment sites appear to fall into the same level of the hierarchy, EPA selects sites for visits strictly on the basis of which facility could most expeditiously be visited and later sampled if justified by the engineering visit.

(2) Engineering Site Visit. Once a treatment facility has been selected, an engineering site visit is made to confirm that a candidate for sampling meets EPA's criteria for a well-designed facility and to ensure that the necessary sampling points can be accessed to determine operating parameters and treatment effectiveness. During the visit, EPA also confirms that the facility appears to be well operated, although the actual operation of the treatment system during sampling is the basis for EPA's decisions regarding

proper operation of the treatment unit. In general, the Agency considers a well-designed facility to be one that contains the unit operations necessary to treat the various hazardous constituents of the waste, as well as to control other nonhazardous materials in the waste that may affect treatment performance.

In addition to ensuring that a system is reasonably well designed, the engineering visit examines whether the facility has a way to measure the operating parameters that affect performance of the treatment system during the waste treatment period. For example, EPA may choose not to sample a treatment system that operates in a continuous mode, for which an important operating parameter cannot be continuously recorded. In such systems, instrumentation is important in determining whether the treatment system is operating at design values during the waste treatment period.

(3) Sampling and Analysis Plan. If after the engineering site visit the Agency decides to sample a particular plant, the Agency will then develop a site-specific Sampling and Analysis Plan (SAP) according to the Generic Quality Assurance Project Plan for the Land Disposal Restriction Program ("BDAT"), EPA/530-SW-87-011. In brief, the SAP discusses where the Agency plans to sample, how the samples will be taken, the frequency of sampling, the constituents to be analyzed and the method of analysis, operational parameters to be obtained, and specific laboratory quality control checks on the analytical results.

The Agency will generally produce a draft of the site-specific Sampling and Analysis Plan within 2 to 3 weeks of the engineering visit. The draft of the SAP is then sent to the plant for review and comment. With few exceptions, the draft SAP should be a confirmation of data collection activities discussed with the plant personnel during the engineering site visit. EPA encourages plant personnel to recommend any modifications to the SAP that they believe will improve the quality of the data.

It is important to note that sampling of a plant by EPA does not mean that the data will be used in the development of treatment standards for BDAT. EPA's final decision on whether to use data from a sampled plant depends on the actual analysis of the waste being treated and on the operating conditions at the time of sampling. Although EPA would not plan to sample a facility that was not ostensibly well designed and well operated, there is no way to ensure that at the time of the sampling the facility will not experience operating problems. Additionally, EPA statistically compares its test data to suitable industry-provided data, where available, in its determination of what data to use in developing treatment standards. The methodology for comparing data is presented later in this section.

(Note: Facilities wishing to submit data for consideration in the development of BDAT standards should, to the extent possible, provide sampling information similar to that acquired by EPA. Such facilities should review the Generic Quality Assurance Project Plan for the Land Disposal Restriction Program ("BDAT"), which delineates all of the quality control and quality assurance measures associated with sampling and analysis. (Quality assurance and quality control procedures are summarized in Section 1.2.6 of this document.)

(4) Sampling Visit. The purpose of the sampling visit is to collect samples that characterize the performance of the treatment system and to document the operating conditions that existed during the waste treatment period. At a minimum, the Agency attempts to collect sufficient samples of the untreated waste and solid and liquid treatment residuals so that variability in the treatment process can be accounted for in the development of the treatment standards. To the extent practicable, and within safety constraints, EPA or its contractors collect all samples and ensure that chain-of-custody procedures are conducted so that the integrity of the data is maintained.

In general, the samples collected during the sampling visit will have already been specified in the SAP. In some instances, however, EPA will not be able to collect all planned samples because of changes in the facility operation or plant upsets; EPA will explain any such deviations from the SAP in its follow-up Onsite Engineering Report.

(5) Onsite Engineering Report. EPA summarizes all its data collection activities and associated analytical results for testing at a facility in a report referred to as the Onsite Engineering Report (OER). This report characterizes the waste(s) treated, the treated residual concentrations, the

design and operating data, and all analytical results including methods used and accuracy results. This report also describes any deviations from EPA's suggested analytical methods for hazardous wastes (see Test Methods for Evaluating Solid Waste, SW-846, Third Edition, November 1986).

After the Onsite Engineering Report is completed, the report is submitted to the plant for review. This review provides the plant with a final opportunity to claim any information contained in the report as confidential. Following the review and incorporation of comments, as appropriate, the report is made available to the public with the exception of any material claimed as confidential by the plant.

1.2.4 Hazardous Constituents Considered and Selected for Regulation

(1) Development of BDAT List. The list of hazardous constituents within the waste codes that are targeted for treatment is referred to by the Agency as the BDAT constituent list. This list, provided as Table 1-1, is derived from the constituents presented in 40 CFR Part 261, Appendices VII and VIII, as well as several ignitable constituents used as the basis of listing wastes as F003 and F005. These sources provide a comprehensive list of hazardous constituents specifically regulated under RCRA. The BDAT list consists of those constituents that can be analyzed using methods published in SW-846, Third Edition.

Table 1-1 BDAT Constituent List

BDAT reference no.	Parameter	Cas no.
	Volatiles	
222.	Acetone	67-64-1
1.	Acetonitrile	75-05-8
2.	Acrolein	107-02-8
3.	Acrylonitrile	107-13-1
4.	Benzene	71-43-2
5.	Bromodichloromethane	75-27-4
6.	Bromomethane	74-83-9
223.	n-Butyl alcohol	71-36-3
7.	Carbon tetrachloride	56-23-5
8.	Carbon disulfide	75-15-0
9.	Chlorobenzene	108-90-7
10.	2-Chloro-1,3-butadiene	126-99-8
11.	Chlorodibromomethane	124-48-1
12.	Chloroethane	75-00-3
13.	2-Chloroethyl vinyl ether	110-75-8
14.	Chloroform	67-66-3
15.	Chloromethane	74-87-3
16.	3-Chloropropene	107-05-1
17.	1,2-Dibromo-3-chloropropane	96-12-8
18.	1,2-Dibromoethane	106-93-4
19.	Dibromomethane	74-95-3
20.	Trans-1,4-Dichloro-2-butene	110-57-6
21.	Dichlorodifluoromethane	75-71-8
22.	1,1-Dichloroethane	75-34-3
23.	1,2-Dichloroethane	107-06-2
24.	1,1-Dichloroethylene	75-35-4
25.	Trans-1,2-Dichloroethene	156-60-5
26.	1,2-Dichloropropane	78-87-5
27.	Trans-1,3-Dichloropropene	10061-02-6
28.	cis-1,3-Dichloropropene	10061-01-5
29.	1,4-Dioxane	123-91-1
224.	2-Ethoxyethanol	60-29-7
225.	Ethyl acetate	141-78-6
226.	Ethyl benzene	100-41-4
30.	Ethyl cyanide	107-12-0
227.	Ethyl ether	60-29-7
31.	Ethyl methacrylate	97-63-2
214.	Ethylene oxide	75-21-8
32.	Iodomethane	74-88-4

Table 1-1 (continued)

BDAT reference no.	Parameter	Cas no.
	Volatiles (continued)	
33.	Isobutyl alcohol	78-83-1
228.	Methanol	67-56-1
34.	Methyl ethyl ketone	78-93-3
229.	Methyl isobutyl ketone	108-10-1
35.	Methyl methacrylate	80-62-6
37.	Methacrylonitrile	126-98-7
38.	Methylene chloride	75-09-2
230.	2-Nitropropane	79-46-9
39.	Pyridine	110-86-1
40.	1,1,1,2-Tetrachloroethane	630-20-6
41.	1,1,2,2-Tetrachloroethane	79-34-6
42.	Tetrachloroethene	127-18-4
43.	Toluene	108-88-3
44.	Tribromomethane	75-25-2
45.	1,1,1-Trichloroethane	71-55-6
46.	1,1,2-Trichloroethane	79-00-5
47.	Trichloroethene	79-01-6
48.	Trichloromonofluoromethane	75-69-4
49.	1,2,3-Trichloropropane	96-18-4
231.	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1
50.	Vinyl chloride	75-01-4
215.	1,2-Xylene	97-47-6
216.	1,3-Xylene	108-38-3
217.	1,4-Xylene	106-44-5
	Semivolatiles	
51.	Acenaphthalene	208-96-8
52.	Acenaphthene	83-32-9
53.	Acetophenone	96-86-2
54.	2-Acetylaminofluorene	53-96-3
55.	4-Aminobiphenyl	92-67-1
56.	Aniline	62-53-3
57.	Anthracene	120-12-7
58.	Aramite	140-57-8
59.	Benz(a)anthracene	56-55-3
218.	Benzal chloride	98-87-3
60.	Benzenethiol	108-98-5
61.	Deleted	
62.	Benzo(a)pyrene	50-32-8

Table 1-1 (continued)

BDAT reference no.	Parameter	CAS no.
	Semivolatiles (continued)	
63.	Benzo(b)fluoranthene	205-99-2
64.	Benzo(ghi)perylene	191-24-2
65.	Benzo(k)fluoranthene	207-08-9
66.	p-Benzoquinone	106-51-4
67.	Bis(2-chloroethoxy)methane	111-91-1
68.	Bis(2-chloroethyl)ether	111-44-4
69.	Bis(2-chloroisopropyl)ether	39638-32-9
70.	Bis(2-ethylhexyl)phthalate	117-81-7
71.	4-Bromophenyl phenyl ether	101-55-3
72.	Butyl benzyl phthalate	85-68-7
73.	2-sec-Butyl-4,6-dinitrophenol	88-85-7
74.	p-Chloroaniline	106-47-8
75.	Chlorobenzilate	510-15-6
76.	p-Chloro-m-cresol	59-50-7
77.	2-Chloronaphthalene	91-58-7
78.	2-Chlorophenol	95-57-8
79.	3-Chloropropionitrile	542-76-7
80.	Chrysene	218-01-9
81.	ortho-Cresol	95-48-7
82.	para-Cresol	106-44-5
232.	Cyclohexanone	108-94-1
83.	Dibenz(a,h)anthracene	53-70-3
84.	Dibenzo(a,e)pyrene	192-65-4
85.	Dibenzo(a,i)pyrene	189-55-9
86.	m-Dichlorobenzene	541-73-1
87.	o-Dichlorobenzene	95-50-1
88.	p-Dichlorobenzene	106-46-7
89.	3,3'-Dichlorobenzidine	91-94-1
90.	2,4-Dichlorophenol	120-83-2
91.	2,6-Dichlorophenol	87-65-0
92.	Diethyl phthalate	84-66-2
93.	3,3'-Dimethoxybenzidine	119-90-4
94.	p-Dimethylaminoazobenzene	60-11-7
95.	3,3'-Dimethylbenzidine	119-93-7
96.	2,4-Dimethylphenol	105-67-9
97.	Dimethyl phthalate	131-11-3
98.	Di-n-butyl phthalate	84-74-2
99.	1,4-Dinitrobenzene	100-25-4
100.	4,6-Dinitro-o-cresol	534-52-1
101.	2,4-Dinitrophenol	51-28-5

Table 1-1 (continued)

BOAT reference no.	Parameter	CAS no.
	Semivolatiles (continued)	
102.	2,4-Dinitrotoluene	121-14-2
103.	2,6-Dinitrotoluene	606-20-2
104.	Di-n-octyl phthalate	117-84-0
105.	Di-n-propylnitrosamine	621-64-7
106.	Diphenylamine	122-39-4
219.	Diphenylnitrosamine	86-30-6
107.	1,2-Diphenylhydrazine	122-66-7
108.	Fluoranthene	206-44-0
109.	Fluorene	86-73-7
110.	Hexachlorobenzene	118-74-1
111.	Hexachlorobutadiene	87-68-3
112.	Hexachlorocyclopentadiene	77-47-4
113.	Hexachloroethane	67-72-1
114.	Hexachlorophene	70-30-4
115.	Hexachloropropene	1888-71-7
116.	Indeno(1,2,3-cd)pyrene	193-39-5
117.	Isosafrole	120-58-1
118.	Methapyrilene	91-80-5
119.	3-Methylcholanthrene	56-49-5
120.	4,4'-Methylenebis (2-chloroaniline)	101-14-4
36.	Methyl methanesulfonate	66-27-3
121.	Naphthalene	91-20-3
122.	1,4-Naphthoquinone	130-15-4
123.	1-Naphthylamine	134-32-7
124.	2-Naphthylamine	91-59-8
125.	p-Nitroaniline	100-01-6
126.	Nitrobenzene	98-95-3
127.	4-Nitrophenol	100-02-7
128.	N-Nitrosodi-n-butylamine	924-16-3
129.	N-Nitrosodiethylamine	55-18-5
130.	N-Nitrosodimethylamine	62-75-9
131.	N-Nitrosomethylethylamine	10595-95-6
132.	N-Nitrosomorpholine	59-89-2
133.	N-Nitrosopiperidine	100-75-4
134.	n-Nitrosopyrrolidine	930-55-2
135.	5-Nitro-o-toluidine	99-65-8
136.	Pentachlorobenzene	608-93-5
137.	Pentachloroethane	76-01-7
138.	Pentachloronitrobenzene	82-68-8

Table 1-1 (continued)

BDAT reference no.	Parameter	CAS no.
	Semivolatiles (continued)	
139.	Pentachlorophenol	87-86-5
140.	Phenacetin	62-44-2
141.	Phenanthrene	85-01-8
142.	Phenol	108-95-2
220.	Phthalic anhydride	85-44-9
143.	2-Picoline	109-06-8
144.	Pronamide	23950-58-5
145.	Pyrene	129-00-0
146.	Resorcinol	108-46-3
147.	Safrole	94-59-7
148.	1,2,4,5-Tetrachlorobenzene	95-94-3
149.	2,3,4,6-Tetrachlorophenol	58-90-2
150.	1,2,4-Trichlorobenzene	120-82-1
151.	2,4,5-Trichlorophenol	95-95-4
152.	2,4,6-Trichlorophenol	88-06-2
153.	Tris(2,3-dibromopropyl) phosphate	126-72-7
	Metals	
154.	Antimony	7440-36-0
155.	Arsenic	7440-38-2
156.	Barium	7440-39-3
157.	Beryllium	7440-41-7
158.	Cadmium	7440-43-9
159.	Chromium (total)	7440-47-32
221.	Chromium (hexavalent)	-
160.	Copper	7440-50-8
161.	Lead	7439-92-1
162.	Mercury	7439-97-6
163.	Nickel	7440-02-0
164.	Selenium	7782-49-2
165.	Silver	7440-22-4
166.	Thallium	7440-28-0
167.	Vanadium	7440-62-2
168.	Zinc	7440-66-6
	Inorganics	
169.	Cyanide	57-12-5
170.	Fluoride	16964-48-8
171.	Sulfide	8496-25-8

Table 1-1 (continued)

BOAT reference no.	Parameter	CAS no.
	Organochlorine pesticides	
172.	Aldrin	309-00-2
173.	alpha-BHC	319-84-6
174.	beta-BHC	319-85-7
175.	delta-BHC	319-86-8
176.	gamma-BHC	58-89-9
177.	Chlordane	57-74-9
178.	DDD	72-54-8
179.	DDE	72-55-9
180.	DDT	50-29-3
181.	Dieldrin	60-57-1
182.	Endosulfan I	939-98-8
183.	Endosulfan II	33213-6-5
184.	Endrin	72-20-8
185.	Endrin aldehyde	7421-93-4
186.	Heptachlor	76-44-8
187.	Heptachlor epoxide	1024-57-3
188.	Isodrin	465-73-6
189.	Kepone	143-50-0
190.	Methoxyclor	72-43-5
191.	Toxaphene	8001-35-2
	Phenoxyacetic acid herbicides	
192.	2,4-Dichlorophenoxyacetic acid	94-75-7
193.	Silvex	93-72-1
194.	2,4,5-T	93-76-5
	Organophosphorous insecticides	
195.	Disulfoton	298-04-4
196.	Famphur	52-85-7
197.	Methyl parathion	298-00-0
198.	Parathion	56-38-2
199.	Phorate	298-02-2
	PCBs	
200.	Aroclor 1016	12674-11-2
201.	Aroclor 1221	11104-28-2
202.	Aroclor 1232	11141-16-5

Table 1-1 (continued)

BOAT reference no.	Parameter	CAS no.
	PCBs (continued)	
203.	Aroclor 1242	53469-21-9
204.	Aroclor 1248	12672-29-6
205.	Aroclor 1254	11097-69-1
206.	Aroclor 1260	11096-82-5
	Dioxins and furans	
207.	Hexachlorodibenzo-p-dioxins	-
208.	Hexachlorodibenzofurans	-
209.	Pentachlorodibenzo-p-dioxins	-
210.	Pentachlorodibenzofurans	-
211.	Tetrachlorodibenzo-p-dioxins	-
212.	Tetrachlorodibenzofurans	-
213.	2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6

The initial BDAT constituent list was published in EPA's Generic Quality Assurance Project Plan, March 1987 (EPA/530-SW-87-011). Additional constituents will be added to the BDAT constituent list as more key constituents are identified for specific waste codes or as new analytical methods are developed for hazardous constituents. For example, since the list was published in March 1987, 18 additional constituents (hexavalent chromium, xylenes (all three isomers), benzal chloride, phthalic anhydride, ethylene oxide, acetone, n-butyl alcohol, 2-ethoxyethanol, ethyl acetate, ethyl benzene, ethyl ether, methanol, methyl isobutyl ketone, 2-nitropropane, 1,1,2-trichloro-1,2,2- trifluoroethane, and cyclohexanone) have been added to the list.

Chemicals are listed in Appendix VIII if they are shown in scientific studies to have toxic, carcinogenic, mutagenic, or teratogenic effects on humans or other life-forms, and they include such substances as those identified by the Agency's Carcinogen Assessment Group as being carcinogenic. Including a constituent in Appendix VIII means that the constituent can be cited as a basis for listing toxic wastes.

Although Appendix VII, Appendix VIII, and the F003 and F005 ignitables provide a comprehensive list of RCRA-regulated hazardous constituents, not all of the constituents can be analyzed in a complex waste matrix. Therefore, constituents that could not be readily analyzed in an unknown waste matrix were not included on the initial BDAT list. As mentioned above, however, the BDAT constituent list is a continuously growing list that does not preclude the addition of new constituents when analytical methods are developed.

There are five major reasons that constituents were not included on the BDAT constituent list:

1. Constituents are unstable. Based on their chemical structure, some constituents will either decompose in water or will ionize. For example, maleic anhydride will form maleic acid when it comes in contact with water and copper cyanide will ionize to form copper and cyanide ions. However, EPA may choose to regulate the decomposition or ionization products.

2. EPA-approved or verified analytical methods are not available. Many constituents, such as 1,3,5-trinitrobenzene, are not measured adequately or even detected using any of EPA's analytical methods published in SW-846 Third Edition.

3. The constituent is a member of a chemical group designated in Appendix VIII as not otherwise specified (N.O.S.). Constituents listed as N.O.S., such as chlorinated phenols, are a generic group of some types of chemicals for which a single analytical procedure is not available. The individual members of each such group need to be listed to determine whether the constituents can be analyzed. For each N.O.S. group, all those constituents that can be readily analyzed are included in the BDAT constituent list.

4. Available analytical procedures are not appropriate for a complex waste matrix. Some compounds, such as auramine, can be analyzed as a pure constituent. However, in the presence of other constituents, the recommended analytical method does not positively identify the constituent. The use of high pressure liquid chromatography (HPLC) presupposes a high expectation of finding the specific constituents of interest. In using this procedure to screen samples, protocols would have to be developed on a case-specific basis to verify the identity of constituents present in the samples. Therefore, HPLC is not an appropriate analytical procedure for complex samples containing unknown constituents.

5. Standards for analytical instrument calibration are not commercially available. For several constituents, such as benz(c)acridine, commercially available standards of a "reasonably" pure grade are not available. The unavailability of a

standard was determined by a review of catalogs from specialty chemical manufacturers.

Two constituents (fluoride and sulfide) are not specifically included in Appendices VII and VIII; however, these compounds are included on the BDAT list as indicator constituents for compounds from Appendices VII and VIII such as hydrogen fluoride and hydrogen sulfide, which ionize in water.

The BDAT constituent list presented in Table 1-1 is divided into the following nine groups:

- Volatile organics;
- Semivolatile organics;
- Metals;
- Other inorganics;
- Organochlorine pesticides;
- Phenoxyacetic acid herbicides;
- Organophosphorous insecticides;
- PCBs; and
- Dioxins and furans.

The constituents were placed in these categories based on their chemical properties. The constituents in each group are expected to behave similarly during treatment and are also analyzed, with the exception of the metals and inorganics, by using the same analytical methods.

(2) Constituent Selection Analysis. The constituents that the Agency selects for regulation in each treatability group are, in general, those found in the untreated wastes at treatable concentrations. For certain waste codes, the target list for the untreated waste may have been shortened

(relative to analyses performed to test treatment technologies) because of the extreme unlikelihood that the constituent will be present.

In selecting constituents for regulation, the first step is to summarize all the constituents that were found in the untreated waste at treatable concentrations. This process involves the use of the statistical analysis of variance (ANOVA) test, described in Section 1.2.6, to determine if constituent reductions were significant. The Agency interprets a significant reduction in concentration as evidence that the technology actually "treats" the waste.

There are some instances where EPA may regulate constituents that are not found in the untreated waste but are detected in the treated residual. This is generally the case where presence of the constituents in the untreated waste interferes with the quantification of the constituent of concern. In such instances, the detection levels of the constituent are relatively high, resulting in a finding of "not detected" when, in fact, the constituent is present in the waste.

After determining which of the constituents in the untreated waste are present at treatable concentrations, EPA develops a list of potential constituents for regulation. The Agency then reviews this list to determine if any of these constituents can be excluded from regulation because they would be controlled by regulation of other constituents in the list.

EPA performs this indicator analysis for two reasons: (1) it reduces the analytical cost burdens on the treater and (2) it facilitates implementation of the compliance and enforcement program. EPA's rationale for selection of regulated constituents for this waste code is presented in Section 6.0 of this background document.

(3) Calculation of Standards. The final step in the calculation of the BDAT treatment standard is the multiplication of the average treatment value by a factor referred to by the Agency as the variability factor. This calculation takes into account that even well-designed and well-operated treatment systems will experience some fluctuations in performance. EPA expects that fluctuations will result from inherent mechanical limitations in treatment control systems, collection of treated samples, and analysis of these samples. All of the above fluctuations can be expected to occur at well-designed and well-operated treatment facilities. Therefore, setting treatment standards utilizing a variability factor should be viewed not as a relaxing of section 3004(m) requirements, but rather as a function of the normal variability of the treatment processes. A treatment facility will have to be designed to meet the mean achievable treatment performance level to ensure that the performance levels remain within the limits of the treatment standard.

The Agency calculates a variability factor for each constituent of concern within a waste treatability group using the statistical calculation presented in Appendix A. The equation for calculating the variability factor is the same as that used by EPA for the development of numerous regulations in the Effluent Guidelines Program under the Clean Water Act. The variability factor establishes the instantaneous maximum based on the 99th percentile value.

There is an additional step in the calculation of the treatment standards in those instances where the ANOVA analysis shows that more than one technology achieves a level of performance that represents BDAT. In such instances, the BDAT treatment standard is calculated by first averaging the mean performance value for each technology for each constituent of concern and then multiplying that value by the highest variability factor among the technologies considered. This procedure ensures that all the BDAT technologies used as the basis for the standards will achieve full compliance.

1.2.5 Compliance with Performance Standards

All the treatment standards reflect performance achieved by the best demonstrated available technology (BDAT). As such, compliance with these standards requires only that the treatment level be achieved prior to land disposal. It does not require the use of any particular treatment technology. While dilution of the waste as a means to comply with the standard is prohibited, wastes that are generated in such a way as to naturally meet the standard can be land disposed without treatment. With the exception of treatment standards that prohibit land disposal, all treatment standards proposed are expressed as a concentration level.

EPA has used both total constituent concentration and TCLP analyses of the treated waste as a measure of technology performance. EPA's rationale for when each of these analytical tests is used is explained in the following discussion.

For all organic constituents, EPA is basing the treatment standards on the total constituent concentration found in the treated waste. EPA based its decision on the fact that technologies exist to destroy the various organics compounds. Accordingly, the best measure of performance would be the extent to which the various organic compounds have been destroyed or the total amount of constituent remaining after treatment. (NOTE: EPA's land disposal restrictions for solvent waste codes F001-F005 (51 FR 40572) use the TCLP value as a measure of performance. At the time that EPA promulgated the treatment standards for F001-F005, useful data were not available on total constituent concentrations in treated residuals and, as a result, the TCLP data were considered to be the best measure of performance.)

For all metal constituents, EPA is using both total constituent concentration and/or the TCLP as the basis for treatment standards. The total constituent concentration is being used when the technology basis includes a metal recovery operation. The underlying principle of metal recovery is the reduction of the amount of metal in a waste by separating the metal for recovery; therefore, total constituent concentration in the treated residual is an important measure of performance for this technology. Additionally, EPA also believes that it is important that any remaining metal in a treated residual waste not be in a state that is easily leachable; accordingly, EPA is also using the TCLP as a measure of performance. It is important to note that for wastes for which treatment standards are based on a metal recovery process, the facility has to comply with both the total constituent concentration and the TCLP prior to land disposal.

In cases where treatment standards for metals are not based on recovery techniques but rather on stabilization, EPA is using only the TCLP as a measure of performance. The Agency's rationale is that stabilization is not meant to reduce the concentration of metal in a waste but only to chemically minimize the ability of the metal to leach.

1.2.6 Identification of BDAT

(1) Screening of Treatment Data. This section explains how the Agency determines which of the treatment technologies represent treatment by BDAT. The first activity is to screen the treatment performance data from each of the demonstrated and available technologies according to the following criteria:

1. Design and operating data associated with the treatment data must reflect a well-designed, well-operated system for each treatment data point. (The specific design and operating parameters for each demonstrated technology for this waste code are discussed in Section 3.2 of this document.)
2. Sufficient QA/QC data must be available to determine the true values of the data from the treated waste. This screening criterion involves adjustment of treated data to take into account that the type value may be different from the measured value. This discrepancy generally is caused by other

constituents in the waste that can mask results or otherwise interfere with the analysis of the constituent of concern.

3. The measure of performance must be consistent with EPA's approach to evaluating treatment by type of constituents (e.g., total concentration data for organics, and total concentration and TCLP for metals in the leachate from the residual).

In the absence of data needed to perform the screening analysis, EPA will make decisions on a case-by-case basis as to whether to include the data. The factors included in this case-by-case analysis will be the actual treatment levels achieved, the availability of the treatment data and their completeness (with respect to the above criteria), and EPA's assessment of whether the untreated waste represents the waste code of concern. EPA's application of these screening criteria for this waste code is provided in Section 5.0 of this background document.

(2) Comparison of Treatment Data. In cases in which EPA has treatment data from more than one technology following the screening activity, EPA uses the statistical method known as analysis of variance (ANOVA) to determine if one technology performs significantly better than the others. This statistical method (summarized in Appendix A) provides a measure of the differences between two data sets. If EPA finds that one technology performs significantly better (i.e., the data sets are not homogeneous), BDAT treatment standards are the level of performance achieved by the best technology multiplied by the corresponding variability factor for each regulated constituent.

If the differences in the data sets are not statistically significant, the data sets are said to be homogeneous. Specifically, EPA uses the analysis of variance to determine whether BDAT represents a level of performance achieved by only one technology or represents a level of performance achieved by more than one (or all) of the technologies. If the Agency finds that the levels of performance for one or more technologies are not statistically different, EPA averages the performance values achieved by each technology and then multiplies this value by the largest variability factor associated with any of the acceptable technologies. A detailed discussion of the treatment selection method and an example of how EPA chooses BDAT from multiple treatment systems is provided in Section A-1.

(3) Quality assurance/quality control. This section presents the principal quality assurance/quality control (QA/QC) procedures employed in screening and adjusting the data to be used in the calculation of treatment standards. Additional QA/QC procedures used in collecting and screening data for the BDAT program are presented in EPA's Generic Quality Assurance Project Plan for Land Disposal Restrictions Program ("BDAT") (EPA/530-SW-87-011, March 1987).

To calculate the treatment standards for the Land Disposal Restriction Rules, it is first necessary to determine the recovery value for each constituent (the amount of constituent recovered after spiking, which is the addition of a known amount of the constituent, minus the initial concentration in the samples divided by the amount added) for a spike of the treated residual. Once the recovery value is determined, the following procedures are used to select the appropriate percent recovery value to adjust the analytical data:

1. If duplicate spike recovery values are available for the constituent of interest, the data are adjusted by the lowest available percent recovery value (i.e., the value that will yield the most conservative estimate of treatment achieved). However, if a spike recovery value of less than 20 percent is reported for a specific constituent, the data are not used to set treatment standards because the Agency does not have sufficient confidence in the reported value to set a national standard.

2. If data are not available for a specific constituent but are available for an isomer, then the spike recovery data are transferred from the isomer and the data are adjusted using the percent recovery selected according to the procedure described in (1) above.

3. If data are not available for a specific constituent but are available for a similar class of constituents (e.g., volatile organics, acid-extractable semivolatiles), then spike recovery data available for this class of constituents are transferred. All spike recovery values greater than or equal to 20 percent for a spiked sample are averaged and the constituent concentration is adjusted by the average recovery value. If spiked recovery data are available for more than one sample, the average is calculated for each sample and the data are adjusted by the lowest average value.

4. If matrix spike recovery data are not available for a set of data to be used to calculate treatment standards, then matrix spike recovery data are transferred from a waste that the Agency believes is a similar matrix (e.g., if the data are for an ash from incineration, then data from other incinerator ashes could be used). While EPA recognizes that transfer of matrix spike recovery data from a similar waste is not an exact analysis, this is considered the best approach for adjusting the data to account for the fact that most analyses do not result in extraction of 100 percent of the constituent. In assessing the recovery data to be transferred, the procedures outlined in (1), (2), and (3) above are followed.

The analytical procedures employed to generate the data used to calculate the treatment standards are listed in Appendix B of this document.

In cases where alternatives or equivalent procedures and/or equipment are allowed in EPA's SW-846, Third Edition (November 1986) methods, the specific procedures and equipment used are also documented in this Appendix. In addition, any deviations from the SW-846, Third Edition, methods used to analyze the specific waste matrices are documented. It is important to note that the Agency will use the methods and procedures delineated in Appendix B to enforce the treatment standards presented in Section 7.0 of this document. Accordingly, facilities should use these procedures in assessing the performance of their treatment systems.

1.2.7 BDAT Treatment Standards for "Derived-From" and "Mixed" Wastes

(1) Wastes from Treatment Trains Generating Multiple Residues. In a number of instances, the proposed BDAT consists of a series of operations, each of which generates a waste residue. For example, the proposed BDAT for a certain waste code is based on solvent extraction, steam stripping, and activated carbon adsorption. Each of these treatment steps generates a waste requiring treatment--a solvent-containing stream from solvent extraction, a stripper overhead, and spent activated carbon. Treatment of these wastes may generate further residues; for instance, spent activated carbon (if not regenerated) could be incinerated, generating an ash and possibly a scrubber water waste. Ultimately, additional wastes are generated that may require land disposal. With respect to these wastes, the Agency wishes to emphasize the following points:

1. All of the residues from treating the original listed wastes are likewise considered to be the listed waste by virtue of the derived-from rule contained in 40 CFR Part 261.3(c)(2). (This point is discussed more fully in (2) below.) Consequently, all of the wastes generated in the course of treatment would be prohibited from land disposal unless they satisfy the treatment standard or meet one of the exceptions to the prohibition.

2. The Agency's proposed treatment standards generally contain a concentration level for wastewaters and a concentration level for nonwastewaters. The treatment standards apply to all of the wastes generated in treating the original prohibited waste. Thus, all solids generated from treating these wastes would have to meet the treatment standard for nonwastewaters. All derived-from wastes meeting the Agency definition of wastewater (less than 1 percent TOC and less than 1 percent total filterable solids) would have to meet the treatment standard for wastewaters. EPA wishes to make clear that this approach is not meant to allow partial treatment in order to comply with the applicable standard.

3. The Agency has not performed tests, in all cases, on every waste that can result from every part of the treatment train. However, the Agency's treatment standards are based on treatment of the most concentrated form of the waste. Consequently, the Agency believes that the less concentrated wastes generated in the course of treatment will also be able to be treated to meet this value.

(2) Mixtures and Other Derived-From Residues. There is a further question as to the applicability of the BDAT treatment standards to residues generated not from treating the waste (as discussed above), but from other types of management. Examples are contaminated soil or leachate that is derived from managing the waste. In these cases, the mixture is still deemed to be the listed waste, either because of the derived-from rule (40 CFR Part 261.3(c)(2)(i)) or the mixture rule (40 CFR Part 261.3(a)(2)(iii) and (iv)) or because the listed waste is contained in the matrix (see, for example, 40 CFR Part 261.33(d)). The prohibition for the particular listed waste consequently applies to this type of waste.

The Agency believes that the majority of these types of residues can meet the treatment standards for the underlying listed wastes (with the possible exception of contaminated soil and debris for which the Agency is currently investigating whether it is appropriate to establish a separate treatability subcategorization). For the most part, these residues will be less concentrated than the original listed waste. The Agency's treatment standards also make a generous allowance for process variability by assuming that all treatability values used to establish the standard are lognormally distributed. The waste also might be amenable to a relatively nonvariable form of treatment technology such as incineration. Finally, and perhaps most important, the rules contain a treatability variance that allows a petitioner to demonstrate that its waste cannot be treated to the level specified in the rule (40 CFR Part 268.44(a)). This provision provides a safety valve that allows persons with unusual waste matrices to demonstrate the appropriateness of a different standard. The Agency, to date, has not received any petitions under this provision (for example, for residues contaminated with a prohibited solvent waste), indicating, in the Agency's view, that the existing standards are generally achievable.

(3) Residues from Managing Listed Wastes or that Contain Listed Wastes. The Agency has been asked if and when residues from managing hazardous wastes, such as leachate and contaminated ground water, become subject to the land disposal prohibitions. Although the Agency believes this question to be settled by existing rules and interpretative statements, to avoid any possible confusion the Agency will address the question again.

Residues from managing First Third wastes, listed California List wastes, and spent solvent and dioxin wastes are all considered to be subject to the prohibitions for the underlying hazardous waste. Residues from managing California List wastes likewise are subject to the California List prohibitions when the residues themselves exhibit a characteristic of hazardous waste. This determination stems directly from the derived-from rule in 40 CFR Part 261.3(c)(2) or, in some cases, from the fact that the waste is mixed with or otherwise contains the listed waste. The underlying principle stated in all of these provisions is that listed wastes remain listed until delisted.

The Agency's historic practice in processing delisting petitions that address mixing residuals has been to consider them to be the listed waste and to require that delisting petitioners address all constituents for which the derived-from waste (or other mixed waste) was listed. The language in 40 CFR Part 260.22(b) states that mixtures or derived-from residues can be delisted provided a delisting petitioner makes a demonstration identical to that which a delisting petitioner would make for the underlying waste. Consequently, these residues are treated as the underlying listed waste for delisting purposes. The statute likewise takes this position, indicating that soil and debris that are contaminated with listed spent solvents or dioxin wastes are subject to the prohibition for these wastes even though these wastes are not the originally generated waste, but rather are a residual from management (RCRA section 3004(e)(3)). It is EPA's view that all such residues are covered by the existing prohibitions and treatment standards for the listed hazardous waste that these residues contain and from which they are derived.

1.2.8 Transfer of Treatment Standards

EPA is proposing some treatment standards that are not based on testing of the treatment technology of the specific waste subject to the treatment standard. Instead, the Agency has determined that the constituents present in the subject waste can be treated to the same performance levels as those observed in other wastes for which EPA has previously developed treatment data. EPA believes that transferring treatment performance for use in establishing treatment standards for untested wastes is technically valid in cases where the untested wastes are generated from similar industries, have similar processing steps, or have similar waste characteristics affecting performance and treatment selection. Transfer of treatment standards to similar wastes or wastes from similar processing steps requires little formal analysis. However, in a case where only the industry is similar, EPA more closely examines the waste characteristics prior to deciding whether the untested waste constituents can be treated to levels associated with tested wastes.

EPA undertakes a two-step analysis when determining whether wastes generated by different processes within a single industry can be treated to the same level of performance. First, EPA reviews the available waste characteristic data to identify those parameters that are expected to affect treatment selection. EPA has identified some of the most important constituents and other parameters needed to select the treatment technology appropriate for a given waste. A detailed discussion of each analysis, including how each parameter was selected for each waste, can be found in Section 5 of this document.

Second, when an individual analysis suggests that an untested waste can be treated with the same technology as a waste for which treatment performance data are already available, EPA analyzes a more detailed list of constituents that represent some of the most important waste characteristics that the Agency believes will affect the performance of the technology. By examining and comparing these characteristics, the Agency determines whether the untested wastes will achieve the same level of treatment as the tested waste. Where the Agency determines that the untested waste is easier to treat than the tested waste, the treatment standards can be transferred. A detailed discussion of this transfer process for each waste can be found in later sections of this document.

1.3 Variance from the BDAT Treatment Standard

The Agency recognizes that there may exist unique wastes that cannot be treated to the level specified as the treatment standard. In such a case, a generator or owner/operator may submit a petition to the Administrator requesting a variance from the treatment standard. A particular waste may be significantly different from the wastes considered in establishing treatability groups because the waste contains a more complex matrix that makes it more difficult to treat. For example, complex mixtures may be formed when a restricted waste is mixed with other waste streams by spills or other forms of inadvertent mixing. As a result, the treatability of the restricted waste may be altered such that it cannot meet the applicable treatment standard.

Variance petitions must demonstrate that the treatment standard established for a given waste cannot be met. This demonstration can be made by showing that attempts to treat the waste by available technologies were not successful or by performing appropriate analyses of the waste, including waste characteristics affecting performance, which demonstrate that the waste cannot be treated to the specified levels. Variances will not be granted based solely on a showing that adequate BDAT treatment capacity is unavailable. (Such demonstrations can be made according to the provisions in Part 268.5 of RCRA for case-by-case extensions of the effective date.) The Agency will consider granting generic petitions provided that representative data are submitted to support a variance for each facility covered by the petition.

Petitioners should submit at least one copy to:

The Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

An additional copy marked "Treatability Variance" should be submitted to:

Chief, Waste Treatment Branch
Office of Solid Waste (WH-565)
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

Petitions containing confidential information should be sent with only the inner envelope marked "Treatability Variance" and "Confidential Business Information" and with the contents marked in accordance with the requirements of 40 CFR Part 2 (41 FR 36902, September 1, 1976, amended by 43 FR 4000).

The petition should contain the following information:

1. The petitioner's name and address.
2. A statement of the petitioner's interest in the proposed action.
3. The name, address, and EPA identification number of the facility generating the waste, and the name and telephone number of the plant contact.
4. The process(es) and feed materials generating the waste and an assessment of whether such process(es) or feed materials may produce a waste that is not covered by the demonstration.
5. A description of the waste sufficient for comparison with the waste considered by the Agency in developing BDAT, and an estimate of the average and maximum monthly and annual quantities of waste covered by the demonstration. (Note: The petitioner should consult the appropriate BDAT background document for determining the characteristics of the wastes considered in developing treatment standards.)
6. If the waste has been treated, a description of the system used for treating the waste, including the process design and operating conditions. The petition should include the reasons the treatment standards are not achievable and/or why the petitioner believes the standards are based on inappropriate technology for treating the waste. (Note: The petitioner should refer to the BDAT background document as guidance for

determining the design and operating parameters that the Agency used in developing treatment standards.)

7. A description of the alternative treatment systems examined by the petitioner (if any); a description of the treatment system deemed appropriate by the petitioner for the waste in question; and, as appropriate, the concentrations in the treatment residual or extract of the treatment residual (i.e., using the TCLP, where appropriate, for stabilized metals) that can be achieved by applying such treatment to the waste.
8. A description of those parameters affecting treatment selection and waste characteristics that affect performance, including results of all analyses. (See Section 3.0 for a discussion of waste characteristics affecting performance that the Agency has identified for the technology representing BDAT.)
9. The dates of the sampling and testing.
10. A description of the methodologies and equipment used to obtain representative samples.
11. A description of the sample handling and preparation techniques, including techniques used for extraction, containerization, and preservation of the samples.
12. A description of analytical procedures used, including QA/QC methods.

After receiving a petition for a variance, the Administrator may request any additional information or waste samples that may be required to evaluate and process the petition. Additionally, all petitioners must certify that the information provided to the Agency is accurate under 40 CFR Part 268.4(b).

In determining whether a variance will be granted, the Agency will first look at the design and operation of the treatment system being used. If EPA determines that the technology and operation are consistent with BDAT, the Agency will evaluate the waste to determine if the waste matrix and/or physical parameters are such that the BDAT treatment standards reflect treatment of this waste. Essentially, this latter analysis will concern the parameters affecting treatment selection and waste characteristics affecting performance parameters.

In cases where BDAT is based on more than one technology, the petitioner will need to demonstrate that the treatment standard cannot be met using any of the technologies, or that none of the technologies are appropriate for treatment of the waste.

2.0 INDUSTRY AFFECTED AND WASTE CHARACTERIZATION

As described in Section 1.0, the Hazardous and Solid Waste Amendments (HSWA) specify dates when particular groups of hazardous wastes are prohibited from land disposal. The amendments also require the Environmental Protection Agency to establish treatment standards for each waste that, when met, allow that waste to be land disposed. Wastes listed as K016, K018, K020, and K030, that are generated by the production of chlorinated organic chemicals, are part of the first third of listed wastes to be evaluated by the Agency. K019 is also generated by the production of chlorinated organic chemicals. K019 was originally scheduled for regulation with the second third of listed wastes; however, the Agency has chosen to include K019 in this waste treatability group due to the similarity between K019 and the other chlorinated organic wastes. The purpose of this section is to describe the industry affected by the land disposal restrictions for K016, K018, K019, K020, and K030 and to present available characterization data for these wastes.

Under 40 CFR 261.32 (hazardous wastes from specific sources), wastes identified as K016, K018, K019, K020, and K030 are specifically generated in the production of chlorinated organic chemicals and are listed as follows:

K016: Heavy ends or distillation residues from the production of carbon tetrachloride

K018: Heavy ends from the fractionation column in ethyl chloride production

K019: Heavy ends from the distillation of ethylene dichloride in ethylene dichloride production

K020: Heavy ends from the distillation of vinyl chloride in vinyl chloride monomer production

K030: Column bottoms or heavy ends from the combined production of trichloroethylene and perchloroethylene

The Agency has determined that these listed wastes (K016, K018, K019, K020, and K030) represent a single waste treatability group based on their similar physical and chemical characteristics. As described later in this section, EPA has examined the sources of the wastes, the specific similarities in waste composition, applicable and demonstrated treatment technologies, and attainable treatment performance in order to support a simplified regulatory approach for these five chlorinated organic chemicals wastes.

2.1 Industry Affected and Process Description

The four digit Standard Industrial Classification (SIC) code associated with the production of chlorinated organic chemicals is 2869 (Industrial Organic Chemicals, Not Elsewhere Classified). The Agency estimates that there are seven facilities that produce K016, five facilities that produce K018, sixteen facilities that produce K019, eleven facilities that produce K020, and eight facilities that produce K030. Table 2-1 lists the number of facilities for each waste code by state. Table 2-2 lists the number of facilities for each waste code in each EPA region.

The production of chlorinated organic chemicals typically consists of the reaction of hydrocarbon or chlorocarbon feedstocks with chlorine or

Table 2-1

FACILITIES PRODUCING K016, K018, K019, K020, AND K030 WASTES BY STATE

State (EPA Region)	Number of Facilities					
	K016	K018	K019	K020	K030	Total
Alabama (IV)	1	0	0	0	0	1
California (IX)	1	0	0	0	1	2
Kansas (VII)	1	0	0	0	1	2
Kentucky (IV)	0	0	1	1	0	2
Louisiana (VI)	2	1	9	6	4	22
New Jersey (II)	0	1	0	0	0	1
Texas (VI)	0	2	6	4	2	14
Virginia (III)	0	1	0	0	0	1
West Virginia (III)	2	0	0	0	0	2
Total:	7	5	16	11	8	47

Source: Reference 1

Table 2-2

FACILITIES PRODUCING K016, K018, K019, K020, AND K030 WASTES BY EPA REGION

EPA Region	Number of Facilities K016	K018	K019	K020	K030	Total
I	0	0	0	0	0	0
II	0	1	0	0	0	1
III	2	1	0	0	0	3
IV	1	0	1	1	0	3
V	0	0	0	0	0	0
VI	2	3	15	10	6	36
VII	1	0	0	0	1	2
VIII	0	0	0	0	0	0
IX	1	0	0	0	1	2
X	0	0	0	0	0	0
Total:	7	5	16	11	8	47

Source: Reference 1

hydrogen chloride to form the desired product and other by-products. A generalized process diagram of the production of chlorinated organic chemicals is presented in Figure 2-1. The reaction steps are followed by a series of washing, neutralization, and purification steps to recover the product(s) at the desired quality. Wastes generated in the processes often include spent catalysts, spent wash solutions, light distillation ends, and heavy ends. The characteristics of the specific wastes generated at a facility depend on feedstocks, catalysts, reactor operating conditions, and product purification methods.

Most chlorinated organic chemical products can be produced by a variety of processes. The process used at a particular facility depends upon the size and age of the facility, other products produced at the facility, and the market for chlorinated organic chemicals. Many chlorinated organic chemicals processes are also designed to produce more than one product stream. Product ratios are adjusted to meet market demand by adjusting feedstocks, reactor operating conditions, and product recycle ratios.

2.1.1 K016 Process Description

Heavy ends or distillation residues (commonly referred to as bottoms) from the production of carbon tetrachloride (K016) are generated in the final purification step in carbon tetrachloride production. There are three major commercial processes currently used to produce carbon tetrachloride; K016 is generated by each of these processes.

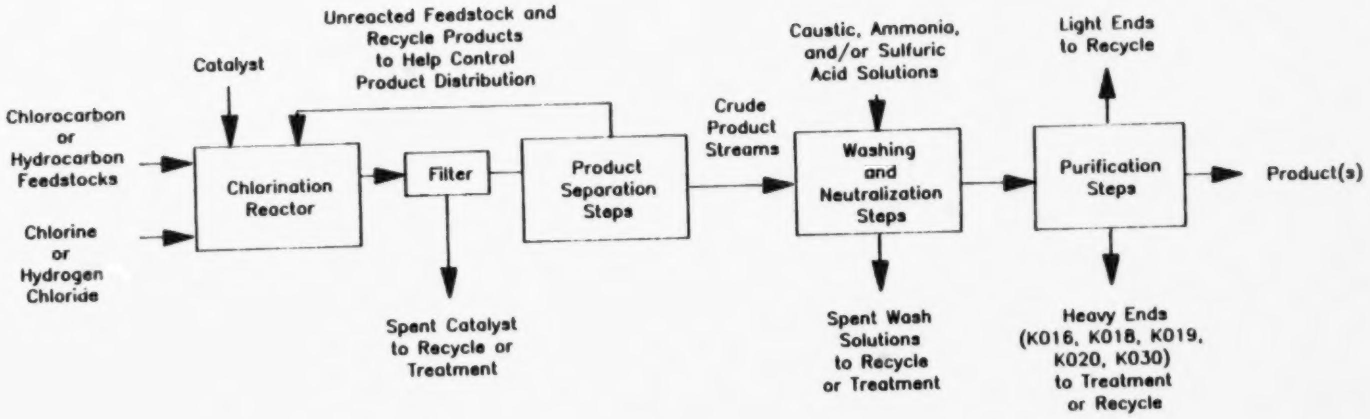
Chlorocarbon or Hydrocarbon Feedstocks
Chlorine or Hydrogen Chloride
Catalyst
Unreacted Feedstock and Recycle Products to Help Control Product Distribution
Chlorination Reactor
Filter
Spent Catalyst to Recycle or Treatment
Product Separation Steps
Crude Product Streams
Caustic, Ammonia, and/or Sulfuric Acid Solutions
Washing and Neutralization Steps
Spent Wash Solutions to Recycle or Treatment
Light Ends to Recycle
Purification Steps
Heavy Ends (K016, K018, K019, K020, K030) to Treatment or Recycle
Product(s)

Figure 2-1

GENERALIZED PROCESS DIAGRAM FOR PRODUCTION OF CHLORINATED ORGANIC CHEMICALS

1. Chlorinolysis of hydrocarbon or chlorocarbon feedstocks;
2. Chlorination of methane; and
3. Chlorination of carbon disulfide.

In the United States, the majority of carbon tetrachloride is produced via the chlorinolysis process. All three processes are discussed in greater detail below.

Chlorinolysis of Hydrocarbon or Chlorocarbon Feedstocks (K016)

The chlorinolysis process consists of the chlorination of hydrocarbons or chlorocarbons at or near pyrolytic conditions. Feedstocks for the chlorinolysis process can be any of several hydrocarbons or a mixture of hydrocarbons including aliphatics (e.g., propane, propene, or butane), chlorinated aliphatics (e.g., hexachloroethane), and chlorinated aromatic hydrocarbons (e.g., chlorobenzene). If propane is selected as the hydrocarbon feedstock, the chemical equation representing its chlorinolysis to carbon tetrachloride and perchloroethylene (tetrachloroethylene) is:

$$\underset{\text{propane}}{C_3H_8} + \underset{\text{chlorine}}{8Cl_2} \text{ -----> } \underset{\text{perchloroethylene}}{C_2Cl_4} + \underset{\substack{\text{carbon}\\\text{tetrachloride}}}{CCl_4} + \underset{\substack{\text{hydrogen}\\\text{chloride}}}{8HCl}$$

The product distribution and the composition of K016 generated are dependent on the feedstock used. The final product distribution can range from greater than 90 percent carbon tetrachloride (using propane as the feedstock) to greater than 90 percent perchloroethylene (using propene as the feedstock).

In the chlorinolysis process, feedstock and chlorine are vaporized in the feedstock vaporizer and are then sent to the chlorinolysis reactor. The products of the chlorinolysis reaction are separated and purified by a series of distillation steps resulting in final products. The bottoms streams from several of the distillation columns (purification and separation steps) are recycled to the feedstock vaporizer to help control the final product distribution. A bottoms stream is continuously purged from the feedstock vaporizer and is fed to another distillation column. The overheads stream from this column is recycled to the vaporizer and the bottoms stream comprises the waste of concern ([illegible] 0).

Chlorination of Methane (K016)

Carbon tetrachloride is produced from methane by a series of chlorination reactions. The chemical reactions that occur are as follows:

CH_4 methane	+	Cl_2 chlorine	----->	CH_3Cl methyl chloride	+	HCl hydrogen chloride
CH_3Cl methyl chloride	+	Cl_2 chlorine	----->	CH_2Cl_2 methylene chloride	+	HCl hydrogen chloride
CH_2Cl_2 methylene chloride	+	Cl_2 chlorine	----->	$CHCl_3$ chloroform	+	HCl hydrogen chloride
$CHCl_3$ chloroform	+	Cl_2 chlorine	----->	CCl_4 carbon tetrachloride	+	HCl hydrogen chloride

Methane feed, recycled reaction intermediates (methyl chloride, methylene chloride, and chloroform), and chlorine are fed to the primary chlorination reactor in the gas phase. The reactor effluent contains unreacted methane and chlorine, and a mixture of chlorinated methane products. The distribution of products is dependent upon the ratio of chlorine to methane to recycled chloromethanes in the feed to the reactor.

Methyl chloride and methylene chloride are recovered from the product stream from the primary chlorination reactor by distillation. The bottoms stream from the methyl chloride and methylene chloride recovery column(s) is then fed to a secondary reactor. The secondary chlorination reaction occurs in the liquid phase in the presence of a catalyst. Chloroform is recovered from the product stream and purified by a series of distillation steps.

The bottoms stream from the chloroform recovery column is further chlorinated in a final reactor to form carbon tetrachloride. Carbon tetrachloride is recovered from the reactor effluent by distillation. The bottoms stream from this distillation column comprises the listed waste K016.

Chlorination of Carbon Disulfide (K016)

The overall chemistry for the production of carbon tetrachloride by the chlorination of carbon disulfide is as follows:

$$\underset{\text{carbon disulfide}}{CS_2} + \underset{\text{chlorine}}{3Cl_2} \;\text{---->}\; \underset{\text{carbon tetrachloride}}{CCl_4} + \underset{\text{sulfur dichloride}}{S_2Cl_2}$$

$$\underset{\text{carbon disulfide}}{CS_2} + \underset{\text{sulfur dichloride}}{2S_2Cl_2} \;\text{---->}\; \underset{\text{sulfur}}{6S} + \underset{\text{carbon tetrachloride}}{CCl_4}$$

Carbon disulfide, sulfur monochloride, and a recycled stream of these reactants and carbon tetrachloride are mixed and fed to the chlorinator where they react with chlorine in the presence of a catalyst. The product stream is fed to a series of stripping and distillation columns for carbon tetrachloride recovery and purification. The distillation bottoms stream from the final carbon tetrachloride purification column comprises the listed waste K016.

2.1.2 K018 Process Description

Heavy ends or distillation residues (bottoms) from the production of ethyl chloride (K018) are generated in the final purification step in ethyl chloride production. In the United States, ethyl chloride is produced via the hydrochlorination of ethylene. In the process, ethylene and anhydrous hydrogen chloride gases are mixed and reacted in the presence of an aluminum chloride catalyst to form ethyl chloride. The chemical reaction that occurs is as follows:

$$\underset{\text{ethylene}}{C_2H_4} + \underset{\text{hydrogen chloride}}{HCl} \xrightarrow{AlCl_3} \underset{\text{ethyl chloride}}{C_2H_5Cl}$$

By-products of the reaction include a hydropolymer oil and other chlorinated hydrocarbons. The crude ethyl chloride is separated from heavier polymers and refined by fractionation. The bottoms stream from this fractionation column comprises the waste of concern (K018).

2.1.3 K019 Process Description

Heavy ends (bottoms) from the distillation of ethylene dichloride (K019) are generated in the final purification step in ethylene dichloride production. In the United States, ethylene dichloride may be produced by the direct chlorination of ethylene or by the oxychlorination of ethylene; however, the vast majority of ethylene dichloride is currently produced using a combination of these two processes. The overall chemical reactions that occur are as follows:

Direct chlorination of ethylene:

$$\underset{\text{chlorine}}{Cl_2} + \underset{\text{ethylene}}{C_2H_4} \dashrightarrow \underset{\text{ethylene dichloride}}{C_2H_4Cl_2}$$

Oxychlorination of ethylene:

$$\underset{\text{ethylene}}{2C_2H_4} + \underset{\text{oxygen}}{O_2} + \underset{\substack{\text{hydrogen}\\\text{chloride}}}{4HCl} \dashrightarrow \underset{\substack{\text{ethylene}\\\text{dichloride}}}{2C_2H_4Cl_2} + \underset{\text{water}}{2H_2O}$$

In the first process, ethylene and chlorine are reacted to produce ethylene dichloride by direct chlorination. In the second process, ethylene is reacted with hydrogen chloride to produce ethylene dichloride by oxychlorination. The crude ethylene dichloride from both processes is then combined and purified using distillation. Heavy ends from the ethylene dichloride purification column comprise the waste of concern (K019).

2.1.4 K020 Process Description

Heavy ends (bottoms) from the distillation of vinyl chloride (K020) are generated in the final purification step in vinyl chloride monomer production. In the United States, there are three processes currently used to produce the vast majority of vinyl chloride monomer; the listed waste K020 is generated by each of these processes.

1. Thermal cracking of ethylene dichloride;
2. Direct chlorination and oxychlorination of ethylene followed by the thermal cracking of ethylene dichloride; and
3. Hydrochlorination of acetylene.

These processes are discussed in greater detail below.

Thermal Cracking of Ethylene Dichloride (K020)

Vinyl chloride monomer is produced by passing ethylene dichloride (EDC) through a cracking furnace. The chemistry of the reaction is as follows:

$$\underset{\text{ethylene dichloride}}{C_2H_4Cl_2} \;\text{----->}\; \underset{\text{vinyl chloride}}{C_2H_3Cl} + \underset{\text{hydrogen chloride}}{HCl}$$

The vinyl chloride monomer product is purified through a series of distillation steps. In the final distillation column, the vinyl chloride monomer product is recovered as the overhead stream. The bottoms stream, consisting of unconverted EDC and higher-boiling hydrocarbons, is the waste of concern (K020). In some processes, this bottoms stream is further distilled to recover ethylene dichloride for recycle to the cracking furnace. In these processes, the heavy ends stream from the ethylene dichloride recovery column is the waste of concern (K020).

Direct Chlorination and Oxychlorination of Ethylene Followed by the Thermal Cracking of Ethylene Dichloride (K020)

This process uses two sub-processes to produce ethylene dichloride (EDC), which is subsequently cracked in a furnace to form the vinyl chloride monomer (VCM). The chemical reactions that occur are as follows:

Direct chlorination of ethylene:

$$\underset{\text{chlorine}}{Cl_2} + \underset{\text{ethylene}}{C_2H_4} \longrightarrow \underset{\text{ethylene dichloride}}{C_2H_4Cl_2}$$

Oxychlorination of ethylene:

$$\underset{\text{ethylene}}{2C_2H_4} + \underset{\text{oxygen}}{O_2} + \underset{\substack{\text{hydrogen}\\\text{chloride}}}{4HCl} \longrightarrow \underset{\substack{\text{ethylene}\\\text{dichloride}}}{2C_2H_4Cl_2} + \underset{\text{water}}{2H_2O}$$

Thermal cracking of ethylene dichloride:

$$\underset{\text{ethylene dichloride}}{C_2H_4Cl_2} \longrightarrow \underset{\text{vinyl chloride}}{C_2H_3Cl} + \underset{\text{hydrogen chloride}}{HCl}$$

In the first sub-process, ethylene and chlorine are reacted to produce EDC by direct chlorination. In the second sub-process ethylene is reacted with hydrogen chloride (produced from the subsequent thermal cracking operation) to produce EDC by oxychlorination. The crude EDC from both sources can be washed and purified in the same process route and then fed to the EDC cracking furnace.

The vinyl chloride monomer product is purified through a series of distillation steps. In the final purification column, the vinyl chloride monomer product is recovered as the overheads stream. The listed waste K020, consisting of unconverted EDC and higher-boiling hydrocarbons, comprise the bottoms stream. In some processes, this bottoms stream is further distilled to remove EDC for recycle to the cracking furnace. The heavy ends stream from the EDC recovery column is the waste of concern (K020).

Hydrochlorination of Acetylene (K020)

The hydrochlorination of acetylene is a vapor phase reaction between acetylene and hydrogen chloride in the presence of a catalyst. The chemical reaction that occurs is as follows:

$$\underset{\text{acetylene}}{C_2H_2} + \underset{\text{hydrogen chloride}}{HCl} \xrightarrow{\text{catalyst}} \underset{\text{vinyl chloride}}{C_2H_3Cl}$$

Hydrogen chloride and acetylene gas react in a tubular reactor in the presence of a catalyst. The reactor effluent gases consist of vinyl chloride monomer, ethylidene chloride, acetaldehyde, and unreacted acetylene and hydrogen chloride. These gases are quenched, and the unreacted acetylene and hydrogen chloride are recycled to the reactor. The bottoms from the quench column, containing crude vinyl chloride monomer, are washed with caustic and water and purified by distillation. The vinyl chloride monomer product is recovered as the overhead stream from the final purification column, and the bottoms stream is the listed waste K020.

2.1.5 K030 Process Description

Heavy ends or distillation residues (bottoms) from the production of trichloroethylene and perchloroethylene (K030) are generated in the final purification steps in production of these products. In the United States, there are three processes currently used to produce the vast majority of trichloroethylene and perchloroethylene (tetrachloroethylene); the listed waste K030 is generated by each of these processes.

1. Oxychlorination of ethylene dichloride;
2. Direct chlorination of ethylene dichloride and other chlorinated hydrocarbons; and
3. Chlorination of acetylene.

These processes are discussed in greater detail below.

Oxychlorination of Ethylene Dichloride (K030)

Trichloroethylene and perchloroethylene are produced when ethylene dichloride is reacted with oxygen and chlorine in an oxychlorinator. The overall chemical reaction that occurs is as follows:

$$\underset{\substack{\text{ethylene}\\\text{dichloride}}}{8C_2H_4Cl_2} + \underset{\text{chlorine}}{6Cl_2} + \underset{\text{oxygen}}{7O_2} \text{ -----> } \underset{\substack{\text{trichloro-}\\\text{ethylene}}}{4C_2HCl_3} + \underset{\substack{\text{tetrachloro-}\\\text{ethylene}}}{4C_2Cl_4} + \underset{\text{water}}{14H_2O}$$

The feed proportions can be adjusted to vary the product ratio from nearly all tetrachloroethylene to nearly all trichloroethylene.

The oxychlorinator is typically a fluidized bed reactor where an oxychlorination catalyst, such as copper chloride, is used. The reactor effluent is processed through a condenser and a decanter.

The organic layer from the decanter is dried in an azeotropic distillation column. The resulting chlorohydrocarbon products are then separated in the trichloroethylene/perchloroethylene (TCE/PCE) distillation column. The TCE is removed as the overhead stream and the PCE is removed as the bottoms stream.

The crude TCE is refined by distillation and is removed as the bottoms stream. (The overheads stream is recycled to the oxychlorinator). The crude PCE is also refined by distillation and is removed as the overheads stream. The bottoms stream from the perchloroethylene distillation column is the listed waste K030.

Direct Chlorination of Ethylene Dichloride and Other Chlorinated Hydrocarbons (K030)

Trichloroethylene and perchloroethylene, in addition to hydrogen chloride, trichloroethane, and carbon tetrachloride, are produced when ethylene dichloride and other high-boiling chlorohydrocarbons are reacted with chlorine. The chemical reactions that occur are as follows:

$$\underset{\substack{\text{ethylene}\\ \text{dichloride}}}{C_2H_4Cl_2} + \underset{\text{chlorine}}{2Cl_2} \text{ -----> } \underset{\substack{\text{trichloro-}\\ \text{ethylene}}}{C_2HCl_3} + \underset{\substack{\text{hydrogen}\\ \text{chloride}}}{3HCl}$$

$$\underset{\substack{\text{ethylene}\\ \text{dichloride}}}{C_2H_4Cl_2} + \underset{\text{chlorine}}{3Cl_2} \text{ -----> } \underset{\substack{\text{tetrachloro-}\\ \text{ethylene}}}{C_2Cl_4} + \underset{\substack{\text{hydrogen}\\ \text{chloride}}}{4HCl}$$

$$\underset{\substack{\text{1,1,2-trichloro-}\\ \text{ethane}}}{ClCH_2CHCl_2} + \underset{\text{chlorine}}{Cl_2} \longrightarrow \underset{\substack{\text{trichloro-}\\ \text{ethylene}}}{C_2HCl_3} + \underset{\substack{\text{hydrogen}\\ \text{chloride}}}{2HCl}$$

$$\underset{\substack{\text{ethylene}\\ \text{dichloride}}}{C_2H_4Cl_2} + \underset{\text{chlorine}}{5Cl_2} \longrightarrow \underset{\substack{\text{carbon}\\ \text{tetrachloride}}}{2CCl_4} + \underset{\substack{\text{hydrogen}\\ \text{chloride}}}{4HCl}$$

The reaction products are quenched and refined by distillation. Unreacted ethylene dichloride is also recovered and recycled to the reactor. In the final distillation column, the perchloroethylene product is recovered as the overheads stream. The bottoms stream from the perchloroethylene recovery column is the waste of concern (K030).

Chlorination of Acetylene (K030)

Trichloroethylene and perchloroethylene are produced when acetylene is reacted with chlorine. The chemical reactions that occur are as follows:

Direct chlorination of acetylene:

$$\underset{\text{acetylene}}{C_2H_2} + \underset{\text{chlorine}}{2Cl_2} \xrightarrow{\text{catalyst}} \underset{\text{tetrachloroethane}}{C_2H_2Cl_4}$$

Thermal cracking of tetrachloroethane intermediate:

$$\underset{\text{tetrachloroethane}}{C_2H_2Cl_4} \longrightarrow \underset{\text{trichloroethylene}}{C_2HCl_3} + \underset{\text{hydrogen chloride}}{HCl}$$

Direct chlorination of tetrachoroethane intermediate:

$$\underset{\text{tetrachloroethane}}{C_2H_2Cl_4} + \underset{\text{chlorine}}{Cl_2} \longrightarrow \underset{\text{perchloroethylene}}{C_2Cl_4} + \underset{\text{hydrogen chloride}}{2HCl}$$

Acetylene, chlorine, and a catalyst are fed to the chlorinator which contains a large mass of liquid tetrachloroethane boiling under reduced pressure. The reactor effluent, the tetrachloroethane intermediate, is condensed and may be split into the following three streams:

(1) Recycle to the acetylene chlorinator,

(2) Feed to the pyrolysis reactor for thermal cracking to trichloroethylene, and/or

(3) Feed to the tetrachloroethane chlorinator for production of perchloroethylene.

In the thermal cracking to trichloroethylene, condensed tetrachloroethane, a trichloroethylene recycle stream, and a catalyst are fed to the thermal cracking reactor. The effluent from this reactor is distilled to recover trichloroethylene product as the overheads stream. The bottoms stream om the trichloroethylene recovery column is the waste of concern (K030). A portion of the waste stream may be purged to remove tars and the remainder recycled to the pyrolysis reactor.

In the direct chlorination of tetrachloroethane, condensed tetrachloroethane is reacted with chlorine to produce perchloroethylene. The reactor effluent is distilled to recover perchloroethylene product as the overheads stream. The bottoms stream from the perchloroethylene recovery column is the waste of concern (K030). A portion of the waste stream may be purged to remove tars and the remainder recycled to the thermal cracking reactor.

2.2 Waste Characterization

This section presents all waste characterization data available to the Agency for K016, K018, K019, K020, and K030. The approximate concentrations of major constituents comprising these wastes are included in Table 2-3. The percent concentrations in the wastes were estimated using engineering judgment based on chemical analyses (analytical data upon which the estimates were based are reported in references 9, 10, and 11). Calculations supporting these estimates are presented in Appendix B.

Tables 2-4 through 2-8 present, by waste code, the ranges of BDAT constituents and other parameters identified for the waste. These data were obtained from a variety of sources as referenced on the tables including literature and sampling and analysis episodes. These wastes contain chlorinated aliphatic and aromatic compounds such as chlorinated ethanes, methanes, benzenes, and butadienes. Additionally, these wastes typically contain low concentrations of metals and may contain high levels of filterable solids.

2.3 Determination of Waste Treatability Group

Fundamental to waste treatment is the concept that the type of treatment technology used and the level of treatment achievable depend on the physical and chemical characteristics of the waste. In cases where EPA believes that constituents present in wastes represented by different codes can be treated to similar concentrations by using the same technologies, the Agency combines the codes into one separate treatability group.

Based on a careful review of the generation of K016, K018, K019, K020, and K030 and all available data characterizing these wastes, the Agency has determined that these wastes represent a single waste treatability group. K016, K018, K019, K020, and K030 are all still bottoms generated by similar processes: the chlorination or oxychlorination of hydrocarbon feedstocks often at high temperatures and pressures. Wastes generated as column bottoms from the purification of chlorinated organic product streams are typically comprised of chlorinated aliphatic and aromatic compounds such as chlorinated ethanes, methanes, benzenes, and butadienes. These wastes typically contain low concentrations of metals. Although the concentrations of specific constituents will vary from facility to facility, all of the wastes contain similar levels of BDAT organics and metals and are expected to be treatable to the same levels using the same technology. As a result, EPA has examined the sources and characteristics of the wastes, applicable and demonstrated treatment technologies, and attainable treatment performance in order to support a single regulatory approach for these five chlorinated organic chemicals wastes.

Table 2-3

MAJOR CONSTITUENTS IN K016, K018, K019, K020, AND K030 WASTES

Constituent	Concentration (%)				
	K016	K018	K019	K020	K030
BDAT List Constituents:					
Chloroethane	-	13	-	-	-
1,1-Dichloroethane	-	36	-	-	-
1,2-Dichloroethane	-	5	10	*	-
Hexachlorobenzene	3	-	-	-	-
Hexachlorobutadiene	6	-	-	-	4
Hexachloroethane	3	-	-	-	-
Pentachloroethane	-	-	-	-	2
1,1,2,2-Tetrachloroethane	-	-	-	*	-
Tetrachloroethene	8	-	-	*	56
1,1,2-Trichloroethane	-	1	4	*	-
Other BDAT List constituents	1	1	2	-	3
Other constituents	78	44	82	*	35
Water	-	-	2	-	-
TOTAL	100	100	100	100	100

-This constituent has not been detected in the waste or represents less than 1% of the total composition.

Sources: Environ Report (Reference 9), Onsite Engineering Report for Rollins (Reference 10), Analytical Data Reports (Reference 11).

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 2-4

AVAILABLE CHARACTERIZATION DATA FOR K016

Source of Data:	Untreated Waste Concentration, ppm (a)	(b)	Range
BDAT List Organics			
Volatiles			
42. Tetrachloroethene	*	*	*
Semivolatiles			
110. Hexachlorobenzene	*	*	*
111. Hexachlorobutadiene	*	*	*
112. Hexachlorocyclopentadiene	*	*	*
113. Hexachloroethane	*	*	*
Other Parameters	(c)		
pH (standard units)	5.7		

(a) Analytical Data Report (Reference 11).
(b) Analytical Data Report (Reference 11).
(c) Environ Report, Reference 9.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 2-5

AVAILABLE CHARACTERIZATION DATA FOR K018

	Untreated Waste Concentration, ppm		
Source of Data:	(a)	(b)	Range
BDAT List Organics			
Volatiles			
12. Chloroethane	*	*	*
15. Chloromethane	*	*	*
22. 1,1-Dichloroethane	*	*	*
23. 1,2-Dichloroethane	*	*	*
45. 1,1,1-Trichloroethane	*	*	*
46. 1,1,2-Trichloroethane	*	*	*
Semivolatiles			
110. Hexachlorobenzene	*	*	*
111. Hexachlorobutadiene	*	*	*
113. Hexachloroethane	*	*	*
137. Pentachloroethane	*	*	*
Other Parameters			
No data are available.			

(a) Analytical Data Report (Reference 11).
(b) Analytical Data Report (Reference 11).
(c) This constituent was also detected in the blank; Results of the blank analysis were not contained in the ADR. The contaminant concentration in the blank is believed to be insignificant in comparison to the constituent concentration in the corresponding sample.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 2-6

AVAILABLE CHARACTERIZATION DATA FOR K019

	Untreated Waste Concentration, ppm			
Source of Data:	(a)	(b)	(d)	Range
BDAT List Organics				
Volatiles				
7. Carbon tetrachloride	3,500-4,100	*	*	*
9. Chlorobenzene	<2,000-3,000	*	*	*
14. Chloroform	4,600-6,000	*	*	*
22. 1,1-Dichloroethane	<2,000-2,200	*	*	*
23. 1,2-Dichloroethane	87,000-130,000	*	*	*
41. 1,1,2,2-Tetrachloroethane	<2,000	*	*	*
42. Tetrachloroethene	6,000-7,800	*	*	*
45. 1,1,1-Trichloroethane	33,000-81,000	*	*	*
46. 1,1,2-Trichloroethane	<2,000	*	*	*
47. Trichloroethene	2,200-3,210	*	*	*
Semivolatiles				
68. Bis(2-chloroethyl) ether	280-340	*	*	*

(a) Onsite Engineering Report from Rollins Environmental Services, Deer Park, TX, Table 6-3, Reference 10
(b) Analytical Data Report (Reference 11).
(c) This constituent was also detected in the blank; results of the blank analysis were not contained in the ADR. The contaminant concentration in the blank is believed to be insignificant in comparison to the constituent concentration in the corresponding sample.
(d) Analytical Data Report (Reference 11).
NA - Not Analyzed

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 2-6 (Continued)

AVAILABLE CHARACTERIZATION DATA FOR K019

Source of Data:	Untreated Waste Concentration, ppm (a)	(b)	(d)	Range
BDAT List Organics (Continued)				
Semivolatiles (Continued)				
88. p-Dichlorobenzene	74-90	*	*	*
109. Fluorene	16-22	*	*	*
110. Hexachlorobenzene	60-87	*	*	*
111. Hexachlorobutadiene	<50	*	*	*
113. Hexachloroethane	85-120	*	*	*
121. Naphthalene	314-470	*	*	*
136. Pentachlorobenzene	51-65	*	*	*
141. Phenanthrene	11-21	*	*	*
148. 1,2,4,5-Tetrachlorobenzene	62-86	*	*	*
150. 1,2,4-Trichlorobenzene	65-100	*	*	*
BDAT List Metals				
155. Arsenic	<0.2-1.2	*	*	*
156. Barium	<0.9-0.97	*	*	*
158. Cadmium	<0.3 - 0.63	*	*	*

(a) Onsite Engineering Report from Rollins Environmental Services, Deer Park, TX, Table 6-3, Reference 10

(b) Analytical Data Report (Reference 11).

(c) This constituent was also detected in the blank; results of the blank analysis were not contained in the ADR. The contaminant concentration in the blank is believed to be insignificant in comparison to the constituent concentration in the corresponding sample.

(d) Analytical Data Report (Reference 11).

NA - Not Analyzed

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 2-6 (Continued)

AVAILABLE CHARACTERIZATION DATA FOR K019

Source of Data:	Untreated Waste Concentration, ppm (a)	(b)	(d)	Range
BDAT List Inorganics				
159. Chromium	1.8-5.3	*	*	*
160. Copper	<1.0-3.6	*	*	*
161. Lead	2.3-3.5	*	*	*
163. Nickel	2.2-6.0	*	*	*
168. Zinc	4.4-9.4	*	*	*
171. Sulfide	790	*	*	*
Other Parameters	(a)	(c)		
BTU content (BTU/lb)	4,012-4,944	2,500-4,500		2,500-4,944
Filterable solids (%)	60.4-83.3	0-1		0-83.3
pH (Standard units)	NA	3		3
TOC (%)	NA	14-25		14-25
TOX (%)	NA	70-85		70-85
Viscosity (mPa-s)	NA	0.49-2		0.49-2

(a) Onsite Engineering Report from Rollins Environmental Services, Deer Park, TX, Table 6-3, Reference 10
(b) Analytical Data Report (Reference 11).
(c) Environ Report, Reference 9
(d) Analytical Data Report (Reference 11).
NA - Not Analyzed

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 2-7

AVAILABLE CHARACTERIZATION DATA FOR K020

Source of Data:	Untreated Waste Concentration, ppm (a)	Range
BDAT List Organics		
Volatiles		
23. 1,2 - Dichloroethane	*	*
41. 1,1,2,2 - Tetrachloroethane	*	*
42. Tetrachloroethene	*	*
46. 1,1,2-Trichloroethane	*	*
Other Parameters	(b)	
Filterable solids (%)	0.5	
pH (standard units)	3	
TOC (%)	38	
TOX (%)	57	
Viscosity (mPa-s)	0.85	

(a) Analytical Data Report (Reference 11).
(b) Environ Report, Reference 9
(c) This constituent was also detected in the blank; results of the blank analysis were not contained in the ADR. The contaminant concentration in the blank is believed to be insignificant in comparison to the constituent concentration in the corresponding sample.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 2-8

AVAILABLE CHARACTERIZATION DATA FOR K030

Source of Data:	Untreated Waste Concentration, ppm (a)	Range
BDAT List Organics		
Volatiles		
42. Tetrachloroethene	*	*
Semivolatiles		
87. o-Dichlorobenzene	*	*
88. p-Dichlorobenzene	*	*
111. Hexachlorobutadiene	*	*
112. Hexachlorocyclopentadiene	*	*
113. Hexachloroethane	*	*
115. Hexachloropropene	*	*
136. Pentachlorobenzene	*	*
137. Pentachloroethane	*	*
148. 1,2,4,5 - Tetrachlorobenzene	*	*
150. 1,2,4 - Trichlorobenzene	*	*
Other Parameters		
No data are available.		

(a) Analytical Data Report (Reference 11).

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

3.0 APPLICABLE/DEMONSTRATED TREATMENT TECHNOLOGIES

In the previous section of this document, the five chlorinated organic wastes (K016, K018, K019, K020, and K030) were characterized and a single waste treatability group was established for these wastes. In this section, treatment technologies applicable for treatment of wastes in this waste group are identified. Detailed descriptions of the technologies that are demonstrated on these wastes or on wastes judged to be similar are presented in this section.

3.1 Applicable Treatment Technologies

Since K016, K018, K019, K020, and K030 contain high concentrations of organic compounds as shown in Section 2.0, applicable technologies include those that destroy or reduce the total amount of various organic compounds in the waste. The Agency has identified the following treatment technologies as applicable for K016, K018, K019, K020, and K030: incineration (fluidized bed, rotary kiln, and liquid injection), critical fluid extraction followed by incineration of the contaminated solvents, and total recycle or reuse. The first technology, incineration, is a destruction technology in which energy, in the form of heat, is transferred to the waste to destabilize chemical bonds and eventually destroy hazardous constituents. In general, two residuals are generated by incineration processes: ash and scrubber water. The second technology, critical fluid extraction, is a solvent extraction technology in which a non-hazardous liquified gas, such as carbon dioxide or propane, is used as solvent. In the extraction step, the gas is brought to its critical state to aid in the extraction of hazardous organic constituents from the wastes. After the extraction step, the solvent (liquified gas at critical state) is brought back to its normal condition in the gaseous state and thus leaves a small volume of concentrated hazardous waste which is further treated by incineration. The third technology is total recycle or reuse of the waste. This technology is usually proprietary and varies from facility to facility.

The treatment technologies applicable for treating organics in K016, K018, K019, K020, and K030 were identified based on current literature sources, field testing, and current waste treatment practices.

The Agency recognizes that wastewater forms of K016, K018, K019, K020, and K030, as defined in Section 1.0, may also be generated from the treatment of these wastes. For example, the incineration of K016, K018, K019, K020, and K030 generates combustion gas scrubber water that would be designated as a wastewater form of K016, K018, K019, K020, and K030 derived from the treatment of these listed wastes. The scrubber water would be expected to contain low levels of metal and organic constituents since the untreated wastes contain low concentrations of metals and the majority of organics would be destroyed in the incinerator. Some wastewaters that are generated by the treatment of K016, K018, K019, K020, and K030 by other technologies may contain organic constituents at treatable concentrations. The Agency has identified the following treatment technologies as potentially applicable for treatment of wastewater forms of K016, K018, K019, K020, and K030: biological treatment, carbon adsorption, and solvent extraction. Since wastewater forms of K016, K018, K019, K020, and K030 may contain organic hazardous constituents at treatable levels, applicable technologies include those that destroy or reduce the total amount of various organic compounds in the waste (i.e., biological treatment, carbon adsorption, and solvent extraction).

3.2 Demonstrated Treatment Technologies

The demonstrated technologies that the Agency has identified for treatment of K016, K018, K019, K020, and K030 are total recycle or reuse and incineration, including rotary kiln, liquid injection, and fluidized bed incineration. Each of the demonstrated technologies are discussed below. At this time, the Agency has no information to determine that any of the five chlorinated waste codes are being treated using critical fluid extraction; therefore, EPA believes that critical fluid extraction is currently not demonstrated at full-scale level.

The Agency is not aware of any facilities that treat wastewater forms of K016, K018, K019, K020, or K030.

A. Total Recycle or Reuse. EPA is aware of three plants that recycle or reuse K016, K019, or K030 as feedstocks in manufacturing processes. Specific information regarding the recycle or reuse of these wastes has been claimed as confidential business information by the facilities.

B. Incineration. Incineration provides for destruction of the organics in the waste. As described in Section 1.0, the best measure of performance for a destruction technology is the total amount of constituent remaining after treatment. Incineration generally results in the formation of two treatment residuals: ash and scrubber water. A detailed description of incineration treatment technology is presented in Section 3.4. The Agency is aware of ten facilities that treat K016, K018, K019, K020, and/or K030 at using liquid injection incineration at a full scale level. Rotary kiln incineration is also demonstrated at a full scale level for these wastes at two facilities. The Agency is also aware of one facility that treats wastes that were generated from the production of vinyl chloride monomer, perchloroethylene and trichloroethylene, using fluidized bed incineration at a full scale level.

The treatment process at Plant A which was tested by the Agency consisted of a rotary kiln, afterburner, and a combustion gas scrubbing system. Combustion exhaust gases from the rotary kiln pass through the kiln exit duct to the afterburner chamber. Kiln ash residue is collected in a storage bin. K019 and another waste were fed to the rotary kiln for treatment by incineration. The K019 treated during the sampling episode was generated during the clean out of a purification column in an ethylene dichloride manufacturing process. The ethylene dichloride manufacturing process used by the generator is the combined ethylene chlorination and oxychlorination process described in Section 2.1.3. The other waste incinerated with K019 (referred to by plant personnel as "RCRA Blend") was a mixture of various industrial wastes including water, oil, and solvents recovered from a waste treatment step at a waste disposal company.

Combustion exhaust gases from the rotary kiln (from rotary kiln treatment of K019 and RCRA Blend waste), and two other wastes ("PCB Blend" waste and mercaptan-contaminated waste) were fed to the afterburner and combustion gas scrubber system for treatment by incineration and wet gas scrubbing. PCB Blend waste is a mixture of RCRA Blend waste and various PCB-containing waste oils including mineral, hydraulic, and transformer oils. Mercaptan-contaminated waste is comprised of site run-off water from plant A and wastewater received by plant A from other sources.

3.3 Available Treatment Technologies

As defined in Section 1.0, an available treatment technology is one that (1) is not a proprietary or patented process that cannot be purchased or licensed from the proprietor (in other words, is commercially available), and (2) substantially diminishes the toxicity of the waste or substantially reduces the likelihood of migration of hazardous constituents from the waste. The demonstrated technology for treatment of K016, K018, K019, K020, and K030, incineration (rotary kiln, fluidized bed, and liquid injection incineration), is considered to be commercially available.

The wastes in this treatability group as generated or upon heating are amenable to pumping and can readily be atomized. This has facilitated the use of liquid injection incineration systems onsite adjacent to the waste generating units. When these wastes are allowed to cool they become viscous and therefore, difficult to atomize. It is common practice to containerize these wastes for offsite transport and disposal. The containerized wastes can be incinerated in a rotary kiln incineration system, as was the case at plant A.

Methods of total recycle or reuse are not considered to be commercially available as they are proprietary or patented process and cannot be purchased or licensed.

3.4 Detailed Description of the Demonstrated Treatment Technology

3.4.1 Incineration

This section addresses the commonly used incineration technologies: liquid injection, rotary kiln, fluidized bed incineration, and fixed hearth. A discussion is provided regarding the applicability of these technologies, the underlying principles of operation, a technology description, waste characteristics that affect performance, and finally important design and operating parameters. As appropriate, the subsections are divided by type of incineration unit.

Applicability and Use of Incineration

Liquid Injection

Liquid injection is applicable to wastes that have viscosity values sufficiently low so that the waste can be atomized and injected into the combustion chamber. Viscosity values for wastes amenable to liquid injection incineration range from 100 SSU to 10,000 SSU as reported in the literature. It is important to note that viscosity is temperature dependent so that while liquid injection may not be applicable to a waste at ambient conditions, it may be applicable when the waste is heated. Other factors that affect the use of liquid injection are particle size and the presence of suspended solids. Both of these waste parameters can cause plugging of the atomizing nozzle.

Rotary Kiln/Fluidized Bed/Fixed Hearth

These incineration technologies are applicable to a wide range of hazardous wastes. They can be used on wastes that contain high or low total organic content, high or low filterable solids, various viscosity ranges, and a range of other waste parameters. EPA has not found these technologies to be applicable for wastes containing high metal concentrations with low organic concentrations. In addition, the Agency expects that air emissions resulting from incineration of wastes containing high metal concentrations may not comply with existing and future air emission limits.

Underlying Principles of Operation

Liquid Injection

The basic operating principle of this incineration technology is that incoming liquid wastes are volatilized and then additional heat is supplied to the waste to destabilize the chemical bonds. Once the chemical bonds are destablized, these constituents react with oxygen to form carbon dioxide and water vapor. The energy needed to destabilize the bonds is referred to as the energy of activation.

Rotary Kiln and Fixed Hearth

There are two distinct principles of operation for these incineration technologies, one for each of the chambers involved. In the primary chamber, energy, in the form of heat, is transferred to the waste to achieve volatilization of the various organic waste constituents. During this volatilization process some of the organic constituents may oxidize to CO_2 and water vapor. In the secondary chamber, additional heat is supplied to overcome the energy requirements needed to destabilize the chemical bonds and allow the constituents to react with excess oxygen to form carbon dioxide and water vapor. The principle of operation for the secondary chamber is similar to liquid injection.

Fluidized Bed

The principle of operation for this incineration technology is somewhat different than for rotary kiln and fixed hearth incineration in that there is only one treatment chamber. The chamber contains the fluidized bed (typically sand) and a freeboard section above the sand. The purpose of the fluidized bed is to both volatilize the waste and combust the waste. Destruction of the waste organics can be accomplished to a better degree in this chamber than in the primary chamber of the rotary kiln and fixed hearth because of 1) improved heat transfer due to fluidization of the waste using forced air and 2) the fact that the fluidization process provides improved turbulence (i.e., mixing) between the waste and oxygen to convert the organics to carbon dioxide and water vapor. Although the fluidized bed incinerator generally does not have an afterburner, the freeboard section provides additional residence time for conversion of the organic constituents to carbon dioxide, water vapor, and hydrochloric acid if chlorine is present in the waste.

Description of Incineration Process

Liquid Injection

The liquid injection system is capable of incinerating a wide range of gases and liquids. The combustion system has a simple design with virtually no moving parts. A burner or nozzle atomizes the liquid waste and injects it into the combustion chamber where it burns in the presence of air or oxygen. A forced draft system supplies the combustion chamber with air to provide oxygen for combustion and turbulence for mixing. The combustion chamber is usually a cylinder lined with refractory (i.e., heat resistant) brick and can be fired horizontally, vertically upward, or vertically downward. Figure 3-1 illustrates a liquid injection incineration system.

Rotary Kiln

A rotary kiln is a slowly rotating, refractory-lined cylinder that is mounted at a slight incline from the horizontal (see Figure 3-2). Solid wastes enter at the high end of the kiln, and liquid or gaseous wastes enter through atomizing nozzles in the kiln or afterburner section. Rotation of the kiln exposes the solids to the heat for vaporization and allows them to combust by mixing with air. The rotation also causes the ash to move to the lower end of the kiln where it can be removed. Rotary kiln systems usually have a secondary combustion chamber or afterburner following the kiln for further combustion of the volatilized components of solid wastes.

Fluidized Bed

A fluidized bed incinerator consists of a column containing inert particles, such as sand, is referred to as the bed. Air, driven by a blower, enters the bottom of the bed to fluidize the sand. The waste material is usually injected directly into the fluidized bed. Air passage through the bed promotes rapid and uniform mixing of the injected waste material within the fluidized bed. The fluidized bed has an extremely high heat capacity

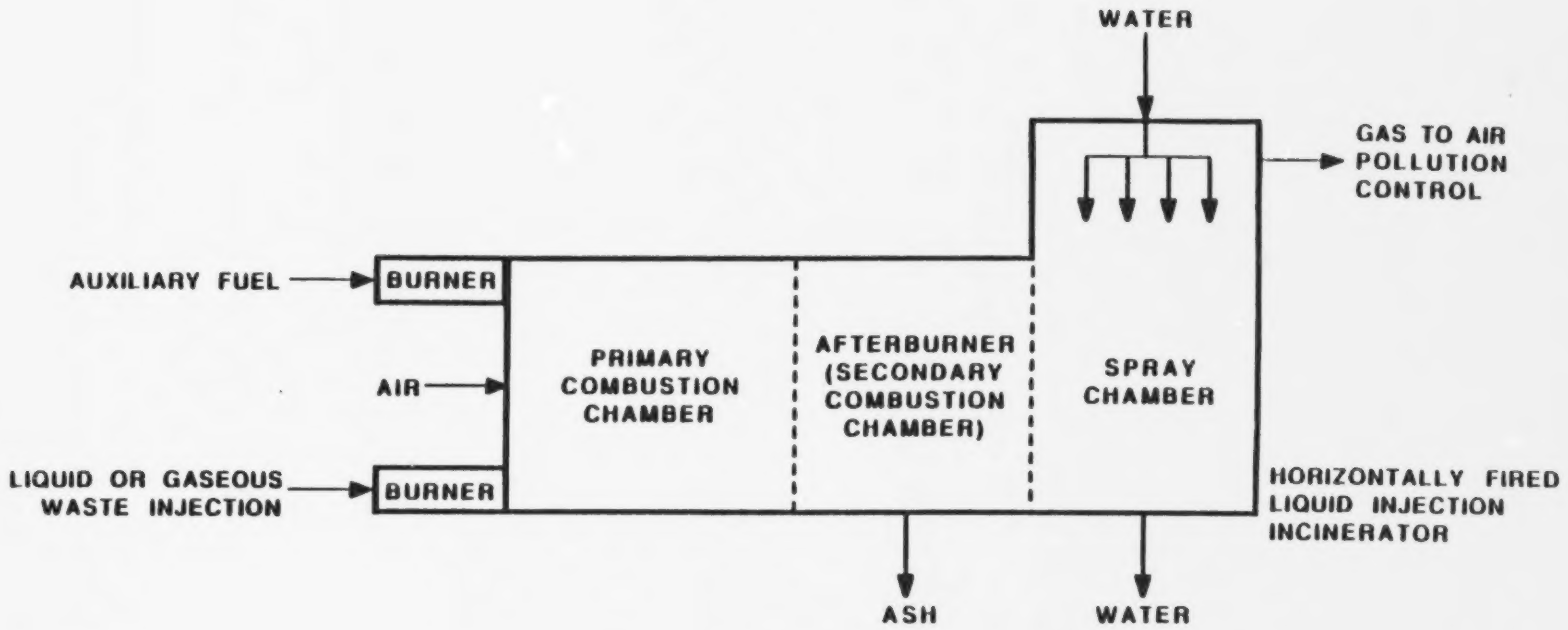
WATER
GAS TO AIR POLLUTION CONTROL
AUXILIARY FUEL
BURNER
AIR
PRIMARY COMBUSTION CHAMBER
AFTERBURNER (SECONDARY COMBUSTION CHAMBER)
SPRAY CHAMBER
LIQUID OR GASEOUS WASTE INJECTION
BURNER
HORIZONTALLY FIRED LIQUID INJECTION INCINERATOR
ASH
WATER

FIGURE 3–1

LIQUID INJECTION INCINERATOR

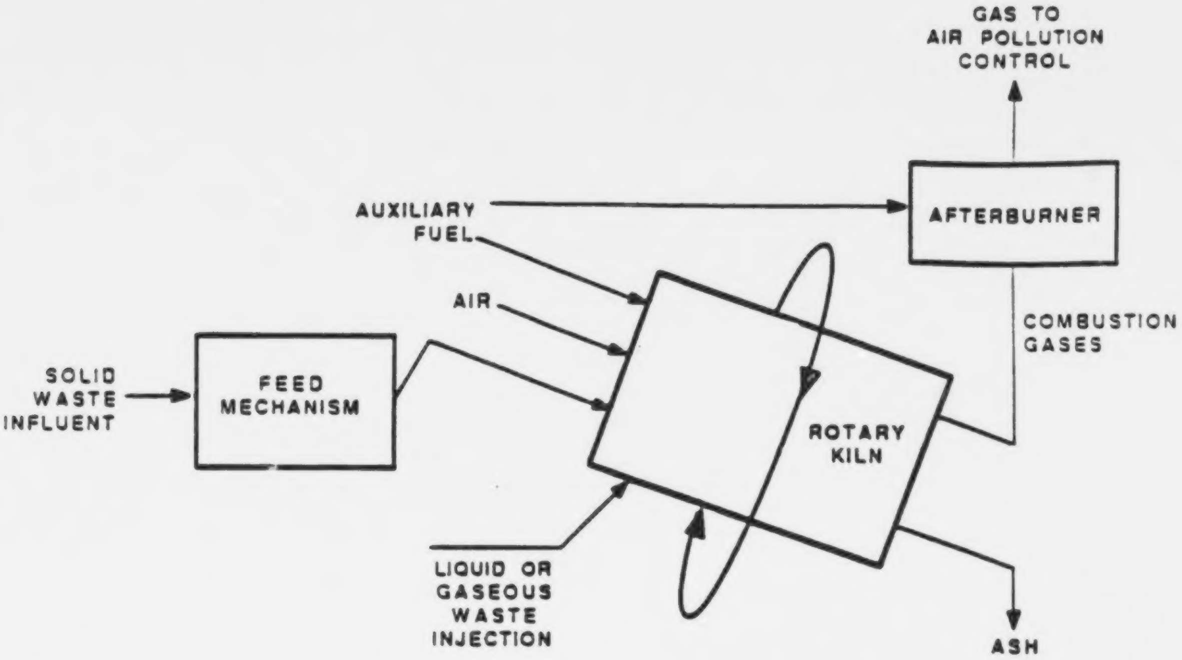
GAS TO
AIR POLLUTION
CONTROL
AUXILIARY
FUEL
AFTERBURNER
AIR
COMBUSTION
GASES
SOLID
WASTE
INFLUENT
FEED
MECHANISM
ROTARY
KILN
LIQUID OR
GASEOUS
WASTE
INJECTION
ASH

FIGURE 3-2

ROTARY KILN INCINERATOR

(approximately three times that of flue gas at the same temperature), thereby providing a large heat reservoir. The injected waste reaches ignition temperature quickly and transfers the heat of combustion back to the bed. Continued bed agitation by the fluidizing air allows larger particles to remain suspended in the combustion zone. (See Figure 3-3.)

Fixed Hearth Incineration

Fixed hearth incinerators, also called controlled air or starved air incinerators, are another major technology used for hazardous waste incineration. Fixed hearth incineration is a two-stage combustion process (see Figure 3-4). Waste is ram-fed into the first stage, or primary chamber, and burned at less than stoichiometric conditions. The resultant smoke and pyrolysis products, consisting primarily of volatile hydrocarbons and carbon monoxide, along with the normal products of combustion, pass to the secondary chamber. Here, additional air is injected to complete the combustion. This two-stage process generally yields low stack particulate and carbon monoxide (CO) emissions. The primary chamber combustion reactions and combustion gas are maintained at low levels by the starved air conditions so that particulate entrainment and carryover are minimized.

Air Pollution Controls

Following incineration of hazardous wastes, combustion gases are generally further treated in an air pollution control system. The presence of chlorine or other halogens in the waste requires a scrubbing or absorption

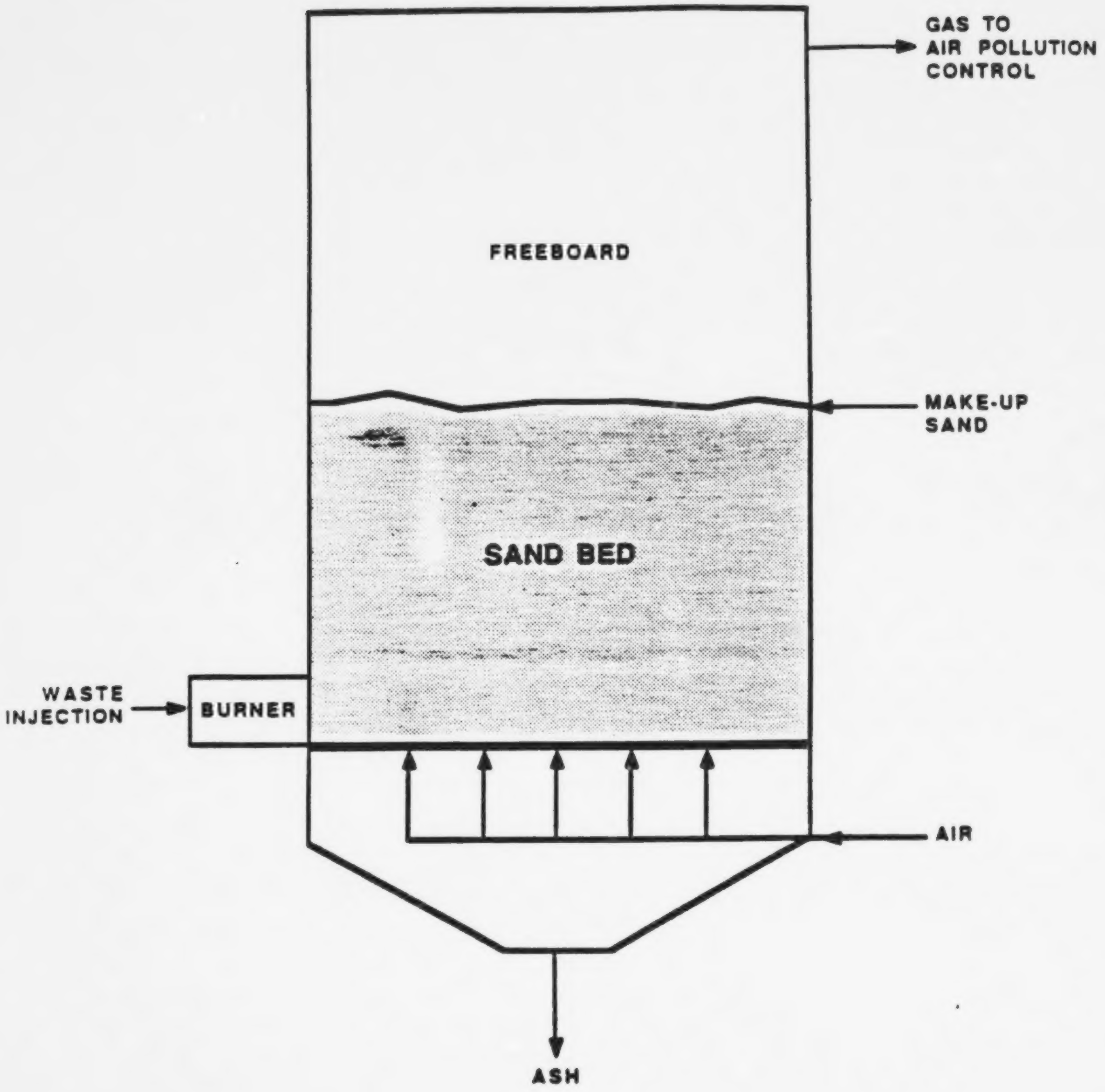
GAS TO
AIR POLLUTION
CONTROL
FREEBOARD
MAKE-UP
SAND
SAND BED
WASTE
INJECTION
BURNER
AIR
ASH

FIGURE 3-3
FLUIDIZED BED INCINERATOR

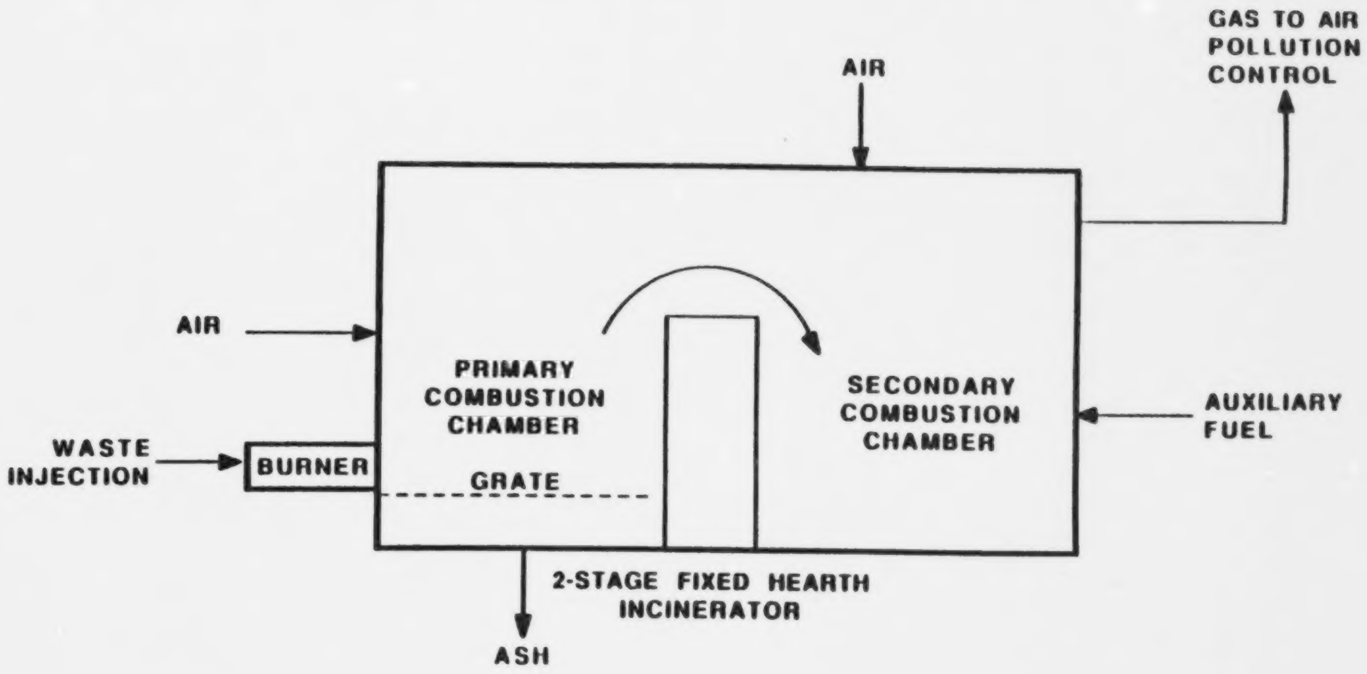
GAS TO AIR
POLLUTION
CONTROL
AIR
AIR
PRIMARY
COMBUSTION
CHAMBER
SECONDARY
COMBUSTION
CHAMBER
AUXILIARY
FUEL
WASTE
INJECTION
BURNER
GRATE
2-STAGE FIXED HEARTH
INCINERATOR
ASH

FIGURE 3-4
FIXED HEARTH INCINERATOR

step to remove HCl and other halo-acids from the combustion gases. Ash in the waste is not destroyed in the combustion process. Ash will either exit as bottom ash, at the discharge end of a kiln or hearth for example, or as particulate matter (fly ash) suspended in the combustion gas stream. Particulate emissions from most hazardous waste combustion systems generally have particle diameters less than one micron and require high efficiency collection devices to minimize air emissions. In addition, scrubber systems provide an additional buffer against accidental releases of incompletely destroyed waste products due to poor combustion efficiency or combustion upsets, such as flame outs.

Waste Characteristics Affecting Performance

Liquid Injection

In determining whether liquid injection is likely to achieve the same level of performance on an untested waste as a previously tested waste, the Agency will compare bond dissociation energies of the constituents in the untested and tested waste. This parameter is being used as a surrogate indicator of activation energy which, as discussed previously, is the amount of energy required to destabilize molecular bonds. Other energy effects (e.g., vibrational energy, the formation of intermediates, and interactions between different molecular bonds) may have a significant influence on activation energy.

Because of the shortcomings of bond energies in estimating activation energy, EPA analyzed other waste characteristic parameters to determine if these parameters would provide a better basis for transferring treatment standards from a tested waste to an untested waste. These parameters include heat of combustion, heat of formation, use of available kinetic data to predict activation energies, and general structural class. All of these were rejected for reasons provided below.

The heat of combustion only measures the difference in energy of the products and reactants; it does not provide information on the activation energy (i.e., the energy input needed to transform the reactants to the transition state to initiate the reaction). Heat of formation is used as a predictive tool for whether reactions are likely to proceed; however, there are a significant number of hazardous constituents for which these data are not available. Use of kinetic data was rejected because these data are limited and could not be used to calculate activation energy values for the wide range of hazardous constituents to be addressed by this rule. Finally, EPA decided not to use structural classes because it believes that evaluation of bond dissociation energies allows for a more direct determination of whether a constituent will be destabilized.

Rotary Kiln/Fluidized Bed/Fixed Hearth

In determining whether these technologies are likely to achieve the same level of performance on an untested waste as a previously tested waste, EPA would need to examine the waste characteristics that affect volatilization of organics from the waste, as well as destruction of the organics, once volatilized based on the underlying principles of operation. Relative to volatilization, EPA will examine thermal conductivity of the entire waste and boiling point of the various constituents. Relative to destruction of organics, as with liquid injection, EPA will examine bond energies. Below is a discussion of how EPA arrived at thermal conductivity and boiling point as the best method to assess volatilization of organics from the waste; the discussion relative to bond energies is the same for these technologies as for liquid injection and will not be repeated here.

(1) Thermal Conductivity. Consistent with the underlying principles of incineration, a major factor with regard to whether a particular constituent will volatilize is the transfer of heat through the waste. In the case of rotary kiln, fluidized bed, and fixed hearth incineration, heat is transferred through the waste by three mechanisms: radiation, convection, and conduction. For a given incinerator, heat transferred through various wastes by radiation is more a function of the design and type of incinerator than of the waste being treated. Accordingly, the type of waste treated will have a minimal impact on the amount of heat transferred by radiation. With regard to convection, EPA also believes that this type of heat transfer will generally be more a function of the type and design of incinerator than of the waste itself. However, EPA is examining particle size as a waste characteristic that may significantly impact the amount of heat transferred to a waste by

convection and thus impact volatilization of the various organic compounds. The final type of heat transfer, conduction, is the one that EPA believes is most dependent upon the specific waste treated. To measure this characteristic, EPA will use thermal conductivity; an explanation of this parameter, as well as how it can be measured, is provided below. Heat flow by conduction is proportional to the temperature gradient across the material. The proportionality constant is a property of the material and is referred to as the thermal conductivity. (Note: The analytical method that EPA has identified for measurement of thermal conductivity is named "Guarded, Comparative, Longitudinal Heat Flow Technique"; it is described in an Appendix to this technology section.) In theory, thermal conductivity would always provide a good indication of whether a constituent in an untested waste would be treated to the same extent in the primary incinerator chamber as it had been treated in a previously tested waste.

In practice, there are some limitations in assessing the transferability of treatment standards using thermal conductivity. However, EPA has not identified a parameter that can provide a better indication of heat transfer characteristics of a waste. Below is a discussion of both the limitations associated with thermal conductivity, as well as other parameters considered.

Thermal conductivity measurements are most meaningful when applied to wastes that are homogeneous (i.e., major constituents are essentially the same). As wastes exhibit greater degrees of non-homogeneity (e.g., significant concentration of metals in soil), thermal conductivity becomes less accurate in predicting treatability because the measurement essentially reflects heat flow through regions having the greatest conductivity (i.e., the path of least resistance) and not heat flow through all parts of the waste.

Btu value, specific heat, and ash content were also considered for predicting heat transfer characteristics. These parameters can no better account for non-homogeneity than thermal conductivity; additionally, they are not directly related to heat transfer characteristics. Therefore, these parameters do not provide a better indication of heat transfer that will occur in any specific waste.

(2) Boiling Point. Once heat is transferred to a constituent within a waste, the removal of this constituent from the waste will depend on its volatility. As a surrogate of volatility, EPA is using boiling point of the constituent. Compounds with lower boiling points have higher vapor pressures and, therefore, would be more likely to vaporize. The Agency recognizes that this parameter does not take into consideration the impact of other compounds in the waste on the boiling point of a constituent in a mixture; however, the Agency is not aware of a better measure of volatility that can easily be determined.

Incineration Design and Operating Parameters

Liquid Injection

For a liquid injection unit, EPA's analysis of whether the unit is well designed will focus on (1) the likelihood that sufficient energy is provided to the waste to overcome the activation level for destabilizing molecular bonds and (2) whether sufficient oxygen is present to convert the waste constituents to carbon dioxide and water vapor. The specific design parameters that the Agency will evaluate to assess whether these conditions are met are: temperature, excess oxygen, and residence time. Below is a discussion of why EPA believes these parameters to be important, as well as a discussion of how these parameters will be monitored during operation.

It is important to point out that, relative to the development of land disposal restriction standards, EPA is only concerned with these design parameters when a quench water or scrubber water residual is generated from treatment of a particular waste. If treatment of a particular waste in a liquid injection unit would not generate a wastewater stream, then the Agency, for purposes of land disposal treatment standards, would only be concerned with the waste characteristics that affect selection of the unit, not the above-mentioned design parameters.

(1) Temperature. Temperature is important in that it provides an indirect measure of the energy available (i.e., Btu/hr) to overcome the

activation energy of waste constituents. As the design temperature increases, the more likely it is that the molecular bonds will be destabilized and the reaction completed.

The temperature is normally controlled automatically through the use of instrumentation which senses the temperature and automatically adjusts the amount of fuel and/or waste being fed. The temperature signal transmitted to the controller can be simultaneously transmitted to a recording device, referred to as a strip chart, and thereby continuously recorded. It is important to know the exact location in the incinerator that the temperature is being monitored.

(2) Excess Oxygen. It is important that the incinerator contain oxygen in excess of the stoichiometric amount necessary to convert the organic compounds to carbon dioxide and water vapor. If insufficient oxygen is present, then destabilized waste constituents could react to form products of incomplete combustion including BDAT List organic compounds and potentially cause the scrubber water to contain higher concentrations of BDAT List constituents than would be the case for a well operated unit.

In practice, the amount of oxygen fed to the incinerator is controlled by continuous sampling and analysis of the stack gas. If the amount of oxygen drops below the design value, then the analyzer transmits a signal to the force draft fan controlling the air supply and thereby increases the flow of oxygen to the afterburner. The analyzer simultaneously transmits a signal to a recording device so that the amount of excess oxygen can be continuously recorded. Again, as with temperature, it is important to know the location from which the combustion gas is being sampled and the location that the design concentration is based.

(3) Carbon Monoxide. Carbon monoxide is an important operating parameter because it provides an indication of the extent to which the waste organic constituents are being converted to CO_2 and water vapor. As the carbon monoxide level increases, it indicates that greater amounts of organic waste constituents are unreacted or partially reacted. Increased carbon monoxide levels can result from insufficient excess oxygen, insufficient turbulence in the combustion zone, or insufficient residence time.

(4) Waste Feed Rate. The waste feed rate is important to monitor because it is related to the residence time. The residence time required is associated with a specific Btu energy value of the feed and a specific volume of combustion gas generated. Prior to incineration, the Btu value of the waste is determined through the use of a laboratory device known as a bomb calorimeter. The volume of combustion gas generated from the waste to be incinerated is determined from an analysis referred to as an ultimate analysis. This analysis determines the amount of elemental constituents present, which includes carbon, hydrogen, sulfur, oxygen, nitrogen, and halogens. Using this analysis plus the total amount of air added, the volume of combustion gas can be calculated. Having determined both the Btu content and the expected combustion gas volume, the feed rate can be fixed at the

desired residence time. Continuous monitoring of the feed rate will determine whether the unit was operated at a rate corresponding to the designed residence time.

Rotary Kiln

For this incineration technology, EPA will examine both the primary and secondary chamber in evaluating the design of a particular incinerator. Relative to the primary chamber, EPA's assessment of design will focus on whether it is likely that sufficient energy will be provided to the waste in order to volatilize the waste constituents. For the secondary chamber, analogous to the liquid injection incineration chamber, EPA will examine the same parameters discussed previously under "Liquid Injection." These parameters will not be discussed again here.

The particular design parameters to be evaluated for the primary chamber are: kiln temperature, residence time, and revolutions per minute. Below is a discussion of why EPA believes these parameters to be important, as well as how these parameters will be monitored during operation.

(1) Temperature. The primary chamber temperature is important in that it provides an indirect measure of the energy input: (i.e., Btu/hr) that is available for heating the waste. The higher the temperature is designed to be in a given kiln, the more likely it is that the constituents will volatilize. As discussed earlier under "Liquid Injection", temperature should be

continuously monitored and recorded. Additionally, it is important to know the location of the temperature sensing device in the kiln.

(2) Residence Time. This parameter is important in that it affects whether sufficient heat is transferred to a particular constituent in order for volatilization to occur. As the time that the waste is in the kiln is increased, a greater quantity of heat is transferred to the hazardous waste constituents. The residence time of solids and gases in the kiln is a function of the specific configuration of the rotary kiln including the length and diameter of the kiln, the waste feed rate, and the rate of rotation.

(3) Revolutions Per Minute (RPM). This parameter provides an indication of the turbulence that occurs in the primary chamber of a rotary kiln. As the turbulence increases, the quantity of heat transferred to the waste would also be expected to increase. However, as the RPM value increases, the residence time of solids in the kiln decreases resulting in a reduction of the quantity of heat transferred to the waste.

Fluidized Bed

As discussed previously, in the section on "Underlying Principles of Operation", the primary chamber accounts for almost all of the conversion of organic wastes to carbon dioxide, water vapor, and acid gas if halogens are present. The freeboard section will generally provide additional residence time for thermal oxidation of the waste constituents. Relative to the primary chamber, the parameters that the Agency will examine in assessing the effectiveness of the design are temperature, residence time, and bed pressure differential. The first two were discussed under rotary kiln and will not be discussed here. The latter, bed pressure differential, is important in that it provides an indication of the amount of turbulence and, therefore, indirectly the amount of heat supplied to the waste. In general, as the pressure drop increases, both the turbulence and heat supplied increase. The pressure drop through the bed should be continuously monitored and recorded to ensure that the design value is achieved.

Fixed Hearth

The design considerations for this incineration unit are similar to a rotary kiln with the exception that rate of rotation (i.e., RPM) is not an applicable design parameter. For the primary chamber of this unit, the parameters that the Agency will examine in assessing how well the unit is designed are the same as discussed under rotary kiln. For the secondary chamber (i.e., afterburner), the design and operating parameters of concern are the same as previously discussed under "Liquid Injection."

Incineration References

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Appendix to Incineration Section

The comparative method of measuring thermal conductivity has been proposed as an ASTM test method under the name "Guarded, Comparative, Logitudinal Heat Flow Technique". A thermal heat flow circuit is used, which is the analog of an electrical circuit with resistances in series. A reference material is chosen to have a thermal conductivity close to that estimated for the sample. Reference standards (also known as heat meters) having the same cross-sectional dimensions as the sample are placed above and below the sample. An upper heater, a lower heater, and a heat sink are added to the "stack" to complete the heat flow circuit. See Figure 1.

The temperature gradients (analogous to potential differences) along the stack are measured with type K (chromel/alumel) thermocouples placed at known separations. The thermocouples are placed into holes or grooves in the references and also in the sample whenever the sample is thick enough to accommodate them.

For molten samples, pastes, greases, and other materials that must be contained, the material is placed into a cell consisting of a top and bottom of Pyrex 7740 and a containment ring of marinite. The sample is 2 inches in diameter and .5 inches thick. Thermocouples are not placed into the sample but rather the temperatures measured in the Pyrex are extrapolated to give the temperature at the top and bottom surfaces of the sample material. The Pyrex disks also serve as the thermal conductivity reference material.

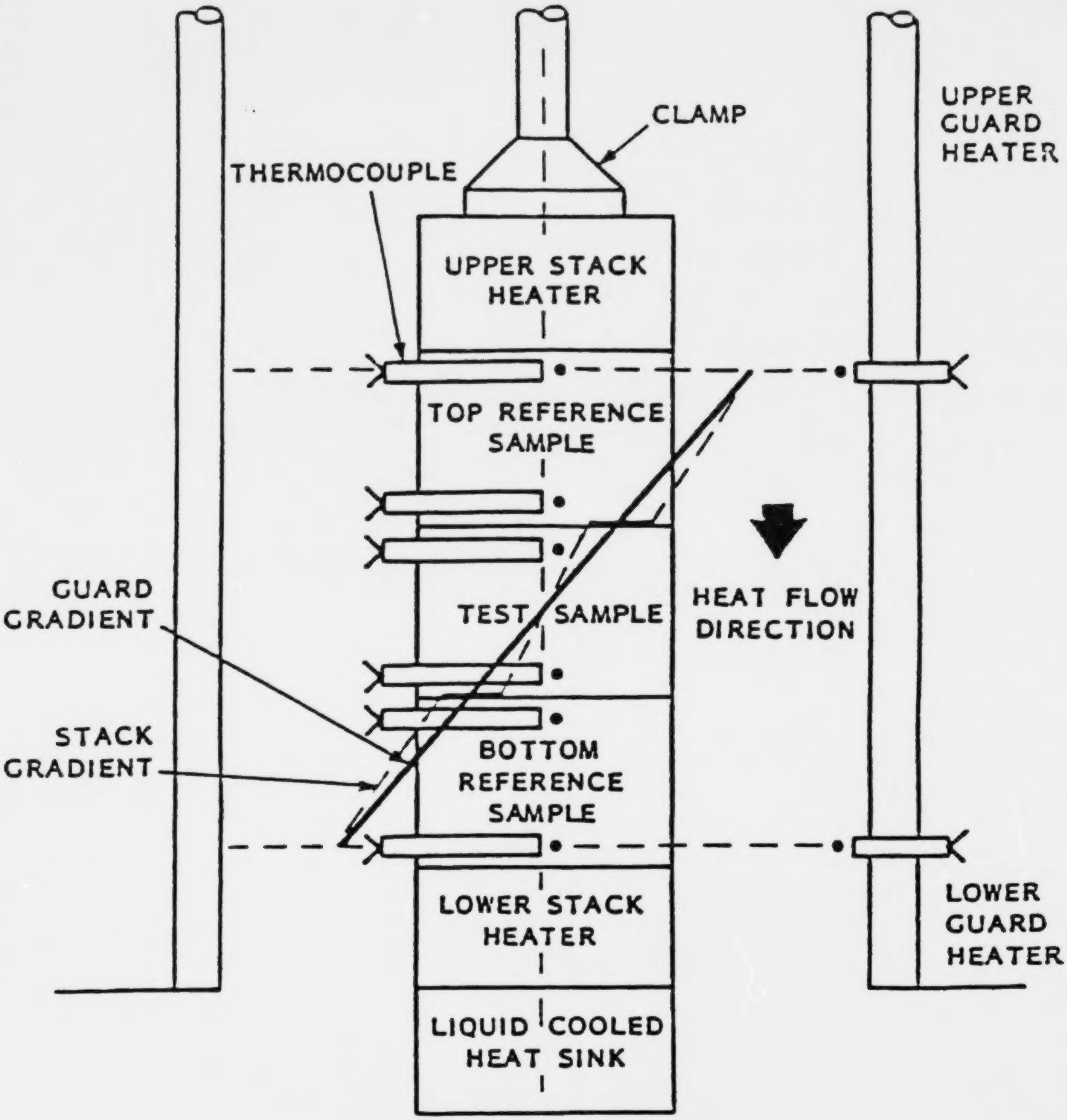
UPPER GUARD HEATER
CLAMP
THERMOCOUPLE
UPPER STACK HEATER
TOP REFERENCE SAMPLE
GUARD GRADIENT
TEST SAMPLE
HEAT FLOW DIRECTION
STACK GRADIENT
BOTTOM REFERENCE SAMPLE
LOWER STACK HEATER
LOWER GUARD HEATER
LIQUID COOLED HEAT SINK

Figure 1.

SCHEMATIC DIAGRAM OF THE COMPARATIVE METHOD

The stack is clamped with a reproducible load to insure intimate contact between the components. In order to produce a linear flow of heat down the stack and reduce the amount of heat that flows radially, a guard tube is placed around the stack and the intervening space is filled with insulating grains or powder. The temperature gradient in the guard is matched to that in the stack to further reduce radial heat flow.

The comparative method is a steady state method measuring thermal conductivity. When equilibrium is reached, the heat flux (analogous to current flow) down the stack can be determined from the references. The heat into the sample is given by

$$Q_{in} = \lambda_{top}\,(dT/dx)_{top}$$

and the heat out of the sample is given by

$$Q_{out} = \lambda_{bottom}\,(dT/dx)_{bottom}$$

where

λ = thermal conductivity

dT/dx = temperature gradient

and top refers to the upper reference while bottom refers to the lower reference. If the heat was confined to flow just down the stack, then Q_{in} and Q_{out} would be equal. If Q_{in} and Q_{out} are in reasonable agreement, the average heat flow is calculated from

$$Q = (Q_{in} + Q_{out})/2$$

The sample thermal conductivity is then found from

$$\lambda_{sample} = Q/(dT/dx)_{sample}$$

The result for the K102 Activated Charcoal Waste tested here is given in Table 4-1. The sample was held at an average temperature of 42°C with a 53°C temperature drop across the sample for approximately 20 hours before the temperature profile became steady and the conductivity measured. At the conclusion of the test it appeared that some "drying" of the sample had occurred.

4.0 AVAILABLE PERFORMANCE DATA

This section presents the data available to the Agency on the treatment of waste K019. Data collected by EPA are available for rotary kiln incineration treatment. EPA's use of this data to develop treatment standards is discussed in Section 5.0 (Identification of BDAT) and Section 7.0 (Calculation of Treatment Standards). Treatment performance data submitted by industry are also presented in this section. Data are available for fluidized bed incineration of wastes generated from the production of vinyl chloride monomer, perchloroethylene, and trichloroethylene. EPA did not use the data submitted by industry to develop treatment standards for K016, K018, K019, K020, and K030, as discussed in Section 5.0.

Tables 4-1 through 4-6 present, by sample set, the BDAT List constituents detected in the untreated (K019 and RCRA Blend) and treated (rotary kiln ash) wastes collected by EPA from the rotary kiln incineration treatment system at plant A. Tables 4-7 through 4-12 present, by sample set, the BDAT List constituents detected in the untreated (K019, RCRA Blend, PCB Blend, and mercaptan-contaminated waste) and treated (scrubber water) wastes collected by EPA from the combustion gas scrubber treatment system following the rotary kiln at plant A. Tables 4-1 through 4-12 also present design and operating data for each sample set. Testing procedures used to analyze these constituents are specifically identified in the analytical quality assurance/quality control discussion of this background document (Appendix D).

Tables 4-13 through 4-15 present, by test run, concentrations of the principal organic hazardous constituents (POHCs) detected in the untreated wastes (generated from the production of vinyl chloride monomer, perchloroethylene, and trichloroethylene) and the treated waste (incinerator ash and scrubber water) wastes from the fluidized bed incineration system from plant B. These tables also present operating conditions for each test.

Table 4-1

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #1

	Untreated Waste		Treated Waste
Detected BDAT List Organic Constituents	K019 Concentration mg/kg (ppm)	RCRA Blend* Concentration mg/kg (ppm)	Kiln Ash Concentration mg/kg (ppm)
VOLATILES			
4. Benzene	<2,000	2,000	<2
7. Carbon tetrachloride	4,000	<8	<2
9. Chlorobenzene	3,000	<8	<2
14. Chloroform	4,600	<8	<2
22. 1,1-Dichloroethane	2,200	<8	<2
23. 1,2-Dichloroethane	93,000	<8	<2
34. Methyl ethyl ketone	<1,000	940	<10
38. Methylene chloride	<1,000	910	<10
42. Tetrachloroethene	7,300	490	<2
43. Toluene	<200	2,300	<2
45. 1,1,1-Trichloroethane	81,000	130	<2
47. Trichloroethene	3,210	360	<2
215-217. Xylene (total)	<200	3,400	<2
222. Acetone	<1,000	1,200	<10
226. Ethyl benzene	<200	2,200	<2
229. Methyl isobutyl ketone	<1,000	1,100	<10
SEMIVOLATILES			
51. Acenaphthalene	<10	150	<2
57. Anthracene	<10	110	<2
65. Benzo(k)fluoranthene	<10	67	<2
68. Bis(2-chloroethyl) ether	280	<20	<2
70. Bis(2-ethylhexyl) phthalate	<10	40	<2
80. Chrysene	SNA	28	<2
87. o-Dichlorobenzene	<10	250	<2
88. p-Dichlorobenzene	81	32	<2
98. Di-n-butyl phthalate	<10	31	<2
108. Fluoranthene	<10	120	<2
109. Fluorene	20	53	<2
110. Hexachlorobenzene	69	<100	<10

SNA A standard is not available; the compound was searched using an NBS Library database of 42,000 compounds. The compound was not detected.

* Only one sample of RCRA Blend waste was taken. The results are repeated in each sample set.

Table 4-1 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #1 (Continued)

	Untreated Waste		Treated Waste	
Detected BDAT List Organic Constituents	K019 Concentration mg/kg (ppm)	RCRA Blend* Concentration mg/kg (ppm)	Kiln Ash Concentration mg/kg (ppm)	Kiln Ash TCLP mg/L (ppm)
SEMIVOLATILES (Continued)				
111. Hexachlorobutadiene	<50	210	<10	
113. Hexachloroethane	120	<100	<10	
121. Naphthalene	470	<20	<2	
126. Nitrobenzene	<25	3,400	<5	
136. Pentachlorobenzene	61	<100	<10	
141. Phenanthrene	21	240	<2	
142. Phenol	<10	78	<2	
145. Pyrene	<10	200	<2	
148. 1,2,4,5-Tetrachlorobenzene	76	<50	<5	
150. 1,2,4-Trichlorobenzene	100	<50	<5	
Detected BDAT List Metal and Inorganic Constituents				
METALS				
154. Antimony	<6.0	24	8.0	<0.060
155. Arsenic	1.2	94	3.6	<0.002
156. Barium	0.97	1.3	26	0.033
158. Cadmium	0.63	<0.3	0.66	<0.003
159. Chromium	4.0	40	44	0.200
160. Copper	2.1	165	2,370	2.690
161. Lead	3.4	27	120	0.380
163. Nickel	3.0	8.8	66	0.680
165. Silver	<0.9	<0.9	3.3	<0.009
167. Vanadium	<2.0	2.2	4.1	<0.020
168. Zinc	5.8	4,170	12	0.052
INORGANICS				
169. Total Cyanide	<0.5	0.9	<0.47	
170. Fluoride	<5.0	31	38	
171. Sulfide	790	830	68	

*Only one sample of RCRA Blend waste was taken. The results are repeated in each sample set.

Table 4-1 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #1 (Continued)

DESIGN AND OPERATING PARAMETERS

Parameter	Design	Operating Value
Kiln Temperature (^{o}F)+	*	1825-1900
Kiln Solids Residence Time (min)	*	120
Waste Feed Rate (MMBTU/hr)+	*	K019: 13.1 RCRA Blend, Waste Burner #1: 3.9-5.5 RCRA Blend, Waste Burner #2: 4.4-9.7
Kiln Rotational Speed (RPM)	*	0.19-0.21

+Strip charts for this parameter are included in Appendix C.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 4-2

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #2

Detected BDAT List Organic Constituents	Untreated Waste K019 Concentration mg/kg (ppm)	Untreated Waste RCRA Blend* Concentration mg/kg (ppm)	Treated Waste Kiln Ash Concentration mg/kg (ppm)
VOLATILES			
4. Benzene	<2,000	2,000	<2
7. Carbon tetrachloride	3,800	<8	<2
9. Chlorobenzene	<2,000	<8	<2
14. Chloroform	5,800	<8	<2
22. 1,1-Dichloroethane	<2,000	<8	<2
23. 1,2-Dichloroethane	96,000	<8	<2
34. Methyl ethyl ketone	<10,000	940	<10
38. Methylene chloride	<10,000	910	<10
42. Tetrachloroethene	6,700	490	<2
43. Toluene	<2,000	2,300	<2
45. 1,1,1-Trichloroethane	33,000	130	<2
47. Trichloroethene	2,400	360	<2
215-217. Xylene (total)	<2,000	3,400	<2
222. Acetone	<10,000	1,200	<10
226. Ethyl benzene	<2,000	2,200	<2
229. Methyl isobutyl ketone	<10,000	1,100	<10
SEMIVOLATILES			
51. Acenaphthalene	<10	150	<2
57. Anthracene	<10	110	<2
65. Benzo(k)fluoranthene	<10	67	<2
68. Bis(2-chloroethyl) ether	280	<20	<2
70. Bis(2-ethylhexyl) phthalate	<10	40	<2
80. Chrysene	SNA	28	<2
87. o-Dichlorobenzene	<10	250	<2
88. p-Dichlorobenzene	74	32	<2
98. Di-n-butyl phthalate	<10	31	<2
108. Fluoranthene	<10	120	<2
109. Fluorene	16	53	<2
110. Hexachlorobenzene	60	<100	<10

SNA A standard is not available; the compound was searched using an NBS Library database of 42,000 compounds. The compound was not detected.

* Only one sample of RCRA Blend waste was taken. The results are repeated in each sample set.

Table 4-2 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #2 (Continued)

	Untreated Waste		Treated Waste	
Detected BDAT List Organic Constituents	K019 Concentration mg/kg (ppm)	RCRA Blend* Concentration mg/kg (ppm)	Kiln Ash Concentration mg/kg (ppm)	Kiln Ash TCLP mg/L (ppm)
SEMIVOLATILES (Continued)				
111. Hexachlorobutadiene	<50	210	<10	
113. Hexachloroethane	85	<100	<10	
121. Naphthalene	314	<20	<2	
126. Nitrobenzene	<25	3,400	<5	
136. Pentachlorobenzene	51	<100	<10	
141. Phenanthrene	15	240	<2	
142. Phenol	<10	78	<2	
145. Pyrene	<10	200	<2	
148. 1,2,4,5-Tetrachlorobenzene	62	<50	<5	
150. 1,2,4-Trichlorobenzene	65	<50	<5	
Detected BDAT List Metal and Inorganic Constituents				
METALS				
154. Antimony	<6.0	24	6.8	<0.060
155. Arsenic	<0.2	94	2.8	<0.002
156. Barium	<0.9	1.3	23	0.036
158. Cadmium	0.46	<0.3	0.96	0.004
159. Chromium	3.4	40	60	0.130
160. Copper	1.7	165	3,430	2.380
161. Lead	2.3	27	42	0.260
163. Nickel	3.6	8.8	89	0.560
165. Silver	<0.9	<0.9	3.4	<0.009
167. Vanadium	<2.0	2.2	4.8	<0.020
168. Zinc	6.9	4,170	13	0.071
INORGANICS				
169. Total Cyanide	<0.5	0.9	<0.47	
170. Fluoride	<5.0	31	5.1	
171. Sulfide	NA	830	<50	

NA Not Analyzed.

*Only one sample of RCRA Blend waste was taken. The results are repeated in each sample set.

Table 4-2 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #2 (Continued)

DESIGN AND OPERATING PARAMETERS

Parameter	Design	Operating Value
Kiln Temperature (^{o}F)+	*	1800-1880
Kiln Solids Residence Time (min)	*	120
Waste Feed Rate (MMBTU/hr)+	*	K019: 12.2 RCRA Blend, Waste Burner #1: 5.2-5.5 RCRA Blend, Waste Burner #2: 4.4-9.7
Kiln Rotational Speed (RPM)	*	0.19-0.21

+Strip charts for this parameter are included in Appendix C.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 4-3

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #3

	Untreated Waste		Treated Waste
Detected BDAT List Organic Constituents	K019 Concentration mg/kg (ppm)	RCRA Blend* Concentration mg/kg (ppm)	Kiln Ash Concentration mg/kg (ppm)
VOLATILES			
4. Benzene	<2,000	2,000	<2
7. Carbon tetrachloride	3,500	<8	<2
9. Chlorobenzene	<2,000	<8	<2
14. Chloroform	5,000	<8	<2
22. 1,1-Dichloroethane	<2,000	<8	<2
23. 1,2-Dichloroethane	87,000	<8	<2
34. Methyl ethyl ketone	<10,000	940	<10
38. Methylene chloride	<10,000	910	<10
42. Tetrachloroethene	6,000	490	<2
43. Toluene	<2,000	2,300	<2
45. 1,1,1-Trichloroethane	34,000	130	<2
47. Trichloroethene	2,200	360	<2
215-217. Xylene (total)	<2,000	3,400	<2
222. Acetone	<10,000	1,200	<10
226. Ethyl benzene	<2,000	2,200	<2
229. Methyl isobutyl ketone	<10,000	1,100	<10
SEMIVOLATILES			
51. Acenaphthalene	<10	150	<2
57. Anthracene	<10	110	<2
65. Benzo(k)fluoranthene	<10	67	<2
68. Bis(2-chloroethyl) ether	290	<20	<2
70. Bis(2-ethylhexyl) phthalate	<10	40	<2
80. Chrysene	SNA	28	<2
87. o-Dichlorobenzene	<10	250	<2
88. p-Dichlorobenzene	80	32	<2
98. Di-n-butyl phthalate	<10	31	<2
108. Fluoranthene	<10	120	<2
109. Fluorene	19	53	<2
110. Hexachlorobenzene	73	<100	<10

SNA A standard is not available; the compound was searched using an NBS Library database of 42,000 compounds. The compound was not detected.

* Only one sample of RCRA Blend waste was taken. The results are repeated in each sample set.

Table 4-3 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #3 (Continued)

	Untreated Waste		Treated Waste	
Detected BDAT List Organic Constituents	K019 Concentration mg/kg (ppm)	RCRA Blend* Concentration mg/kg (ppm)	Kiln Ash Concentration mg/kg (ppm)	Kiln Ash TCLP mg/L (ppm)
SEMIVOLATILES (Continued)				
111. Hexachlorobutadiene	<50	210	<10	
113. Hexachloroethane	95	<100	<10	
121. Naphthalene	350	<20	<2	
126. Nitrobenzene	<25	3,400	<5	
136. Pentachlorobenzene	59	<100	<10	
141. Phenanthrene	11	240	<2	
142. Phenol	<10	78	<2	
145. Pyrene	<10	200	<2	
148. 1,2,4,5-Tetrachlorobenzene	67	<50	5	
150. 1,2,4-Trichlorobenzene	70	<50	<5	
Detected BDAT List Metal and Inorganic Constituents				
METALS				
154. Antimony	<6.0	24	9.2	<0.060
155. Arsenic	<0.2	94	5.7	<0.002
156. Barium	<0.9	1.3	54	0.057
158. Cadmium	0.53	<0.3	3.6	0.005
159. Chromium	3.5	40	202	0.260
160. Copper	1.7	165	2,290	7.030
161. Lead	3.4	27	118	0.620
163. Nickel	2.3	8.8	169	0.960
165. Silver	<0.9	<0.9	1.9	<0.009
167. Vanadium	<2.0	2.2	6.0	<0.020
168. Zinc	4.4	4,170	16	0.170
INORGANICS				
169. Total Cyanide	<0.5	0.9	<0.47	
170. Fluoride	<5.0	31	6.1	
171. Sulfide	NA	830	64	

NA = Not Analyzed.

* Only one sample of RCRA Blend waste was taken. The results are repeated in each sample set.

Table 4-3 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #3 (Continued)

DESIGN AND OPERATING PARAMETERS

Parameter	Design	Operating Value
Kiln Temperature (°F)+	*	1850-1900
Kiln Solids Residence Time (min)	*	120
Waste Feed Rate (MMBTU/hr)+	*	K019: 12.4 RCRA Blend, Waste Burner #1: 5.2-5.8 RCRA Blend, Waste Burner #2: 4.4-8.4
Kiln Rotational Speed (RPM)	*	0.19-0.21

+Strip charts for this parameter are included in Appendix C.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 4-4

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #4

	Untreated Waste		Treated Waste
Detected BDAT List Organic Constituents	K019 Concentration mg/kg (ppm)	RCRA Blend* Concentration mg/kg (ppm)	Kiln Ash Concentration mg/kg (ppm)
VOLATILES			
4. Benzene	<2,000	2,000	<2
7. Carbon tetrachloride	3,900	<8	<2
9. Chlorobenzene	<2,000	<8	<2
14. Chloroform	5,300	<8	<2
22. 1,1-Dichloroethane	<2,000	<8	<2
23. 1,2-Dichloroethane	122,000	<8	<2
34. Methyl ethyl ketone	<10,000	940	<10
38. Methylene chloride	<10,000	910	<10
42. Tetrachloroethene	7,200	490	<2
43. Toluene	<2,000	2,300	<2
45. 1,1,1-Trichloroethane	44,000	130	<2
47. Trichloroethene	2,300	360	<2
215-217. Xylene (total)	<2,000	3,400	<2
222. Acetone	<10,000	1,200	<10
226. Ethyl benzene	<2,000	2,200	<2
229. Methyl isobutyl ketone	<10,000	1,100	<10
SEMIVOLATILES			
51. Acenaphthalene	<10	150	<2
57. Anthracene	<10	110	<2
65. Benzo(k)fluoranthene	<10	67	<2
68. Bis(2-chloroethyl) ether	310	<20	<2
70. Bis(2-ethylhexyl) phthalate	<10	40	12
80. Chrysene	SNA	28	<2
87. o-Dichlorobenzene	<10	250	<2
88. p-Dichlorobenzene	84	32	<2
98. Di-n-butyl phthalate	<10	31	230
108. Fluoranthene	<10	120	<2
109. Fluorene	21	53	<2
110. Hexachlorobenzene	61	<100	<10

SNA A standard is not available; the compound was searched using an NBS Library database of 42,000 compounds. The compound was not detected.

*Only one sample of RCRA Blend waste was taken. The results are repeated in each sample set.

Table 4-4 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #4 (Continued)

	Untreated Waste		Treated Waste	
Detected BDAT List Organic Constituents	K019 Concentration mg/kg (ppm)	RCRA Blend* Concentration mg/kg (ppm)	Kiln Ash Concentration mg/kg (ppm)	Kiln Ash TCLP mg/L (ppm)
SEMIVOLATILES (Continued)				
111. Hexachlorobutadiene	<50	210	<10	
113. Hexachloroethane	94	<100	<10	
121. Naphthalene	360	<20	<2	
126. Nitrobenzene	<25	3,400	<5	
136. Pentachlorobenzene	64	<100	<10	
141. Phenanthrene	19	240	<2	
142. Phenol	<10	78	<2	
145. Pyrene	<10	200	<2	
148. 1,2,4,5-Tetrachlorobenzene	82	<50	<5	
150. 1,2,4-Trichlorobenzene	74	<50	<5	
Detected BDAT List Metal and Inorganic Constituents				
METALS				
154. Antimony	<6.0	24	<6.0	<0.060
155. Arsenic	<0.2	94	5.7	<0.002
156. Barium	<0.9	1.3	8.4	0.036
158. Cadmium	<0.3	<0.3	<0.3	0.005
159. Chromium	1.8	40	28	0.110
160. Copper	<1.0	165	1,270	1.940
161. Lead	2.4	27	25	0.320
163. Nickel	2.2	8.8	69	0.870
165. Silver	<0.9	<0.9	2.6	<0.009
167. Vanadium	<2.0	2.2	<2.0	<0.020
168. Zinc	9.4	4,170	11	0.056
INORGANICS				
169. Total Cyanide	<0.5	0.9	<0.47	
170. Fluoride	<5.0	31	3.2	
171. Sulfide	NA	830	<50	

NA = Not Analyzed.

* Only one sample of RCRA Blend waste was taken. The results are repeated in each sample set.

Table 4-4 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #4 (Continued)

DESIGN AND OPERATING PARAMETERS

Parameter	Design	Operating Value
Kiln Temperature (°F)+	*	1775-1900
Kiln Solids Residence Time (min)	*	120
Waste Feed Rate (MMBTU/hr)+	*	K019: 12.7 RCRA Blend, Waste Burner #1: 5.2-5.8 RCRA Blend, Waste Burner #2: 4.4-7.3
Kiln Rotational Speed (RPM)	*	0.19-0.21

+ Strip charts for this parameter are included in Appendix C.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 4-5

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #5

Detected BDAT List Organic Constituents	Untreated Waste		Treated Waste
	K019 Concentration mg/kg (ppm)	RCRA Blend* Concentration mg/kg (ppm)	Kiln Ash Concentration mg/kg (ppm)
VOLATILES			
4. Benzene	<2,000	2,000	<2
7. Carbon tetrachloride	4,000	<8	<2
9. Chlorobenzene	<2,000	<8	<2
14. Chloroform	6,000	<8	<2
22. 1,1-Dichloroethane	<2,000	<8	<2
23. 1,2-Dichloroethane	130,000	<8	<2
34. Methyl ethyl ketone	<10,000	940	<10
38. Methylene chloride	<10,000	910	<10
42. Tetrachloroethene	7,800	490	<2
43. Toluene	<2,000	2,300	<2
45. 1,1,1-Trichloroethane	45,000	130	<2
47. Trichloroethene	2,500	360	<2
215-217. Xylene (total)	<2,000	3,400	<2
222. Acetone	<10,000	1,200	<10
226. Ethyl benzene	<2,000	2,200	<2
229. Methyl isobutyl ketone	<10,000	1,100	<10
SEMIVOLATILES			
51. Acenaphthalene	<10	150	<2
57. Anthracene	<10	110	<2
65. Benzo(k)fluoranthene	<10	67	<2
68. Bis(2-chloroethyl) ether	340	<20	<2
70. Bis(2-ethylhexyl) phthalate	<10	40	<2
80. Chrysene	SNA	28	<2
87. o-Dichlorobenzene	<10	250	<2
88. p-Dichlorobenzene	90	32	<2
98. Di-n-butyl phthalate	<10	31	<2
108. Fluoranthene	<10	120	<2
109. Fluorene	19	53	<2
110. Hexachlorobenzene	87	<100	<10

SNA A standard is not available; the compound was searched using an NBS Library database of 42,000 compounds. The compound was not detected.

* Only one sample of RCRA Blend waste was taken. The results are repeated in each sample set.

Table 4-5 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #5 (Continued)

	Untreated Waste		Treated Waste	
Detected BDAT List Organic Constituents	K019 Concentration mg/kg (ppm)	RCRA Blend* Concentration mg/kg (ppm)	Kiln Ash Concentration mg/kg (ppm)	Kiln Ash TCLP mg/L (ppm)
SEMIVOLATILES (Continued)				
111. Hexachlorobutadiene	<50	210	<10	
113. Hexachloroethane	113	<100	<10	
121. Naphthalene	371	<20	<2	
126. Nitrobenzene	<25	3,400	<5	
136. Pentachlorobenzene	63	<100	<10	
141. Phenanthrene	19	240	<2	
142. Phenol	<10	78	<2	
145. Pyrene	<10	200	<2	
148. 1,2,4,5-Tetrachlorobenzene	73	<50	<5	
150. 1,2,4-Trichlorobenzene	72	<50	<5	
Detected BDAT List Metal and Inorganic Constituents				
METALS				
154. Antimony	<6.0	24	9.1	<0.060
155. Arsenic	<0.2	94	3.9	<0.002
156. Barium	<0.9	1.3	21	0.054
158. Cadmium	0.36	<0.3	1.2	0.006
159. Chromium	3.2	40	125	0.210
160. Copper	2.1	165	2,780	2.140
161. Lead	2.5	27	86	0.290
163. Nickel	4.8	8.8	166	1.270
165. Silver	<0.9	<0.9	3.3	<0.009
167. Vanadium	<2.0	2.2	5.7	<0.020
168. Zinc	4.7	4,170	22	0.086
INORGANICS				
169. Total Cyanide	<0.5	0.9	<0.47	
170. Fluoride	<5.0	31	23	
171. Sulfide	NA	830	64	

NA = Not Analyzed.

*Only one sample of RCRA Blend waste was taken. The results are repeated in each sample set.

Table 4-5 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #5 (Continued)

DESIGN AND OPERATING PARAMETERS

Parameter	Design	Operating Value
Kiln Temperature (°F)+	*	1775-1800
Kiln Solids Residence Time (min)	*	120
Waste Feed Rate (MMBTU/hr)+	*	K019: 11.7 RCRA Blend, Waste Burner #1: 5.5-6.0 RCRA Blend, Waste Burner #2: 5.2-9.7
Kiln Rotational Speed (RPM)	*	0.19-0.21

+Strip charts for this parameter are included in Appendix C.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 4-6

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #6

Detected BDAT List Organic Constituents	Untreated Waste		Treated Waste
	K019 Concentration mg/kg (ppm)	RCRA Blend* Concentration mg/kg (ppm)	Kiln Ash Concentration mg/kg (ppm)
VOLATILES			
4. Benzene	<2,000	2,000	<2
7. Carbon tetrachloride	4,100	<8	<2
9. Chlorobenzene	<2,000	<8	<2
14. Chloroform	5,600	<8	<2
22. 1,1-Dichloroethane	<2,000	<8	<2
23. 1,2-Dichloroethane	98,000	<8	<2
34. Methyl ethyl ketone	<10,000	940	<10
38. Methylene chloride	<10,000	910	<10
42. Tetrachloroethene	6,900	490	<2
43. Toluene	<2,000	2,300	<2
45. 1,1,1-Trichloroethane	44,000	130	<2
47. Trichloroethene	2,500	360	<2
215-217. Xylene (total)	<2,000	3,400	<2
222. Acetone	<10,000	1,200	<10
226. Ethyl benzene	<2,000	2,200	<2
229. Methyl isobutyl ketone	<10,000	1,100	<10
SEMIVOLATILES			
51. Acenapthalene	<10	150	<2
57. Anthracene	<10	110	<2
65. Benzo(k)fluoranthene	<10	67	<2
68. Bis(2-chloroethyl) ether	330	<20	<2
70. Bis(2-ethylhexyl) phthalate	<10	40	<2
80. Chrysene	SNA	28	<2
87. o-Dichlorobenzene	<10	250	<2
88. p-Dichlorobenzene	90	32	<2
98. Di-n-butyl phthalate	<10	31	<2
108. Fluoranthene	<10	120	<2
109. Fluorene	22	53	<2
110. Hexachlorobenzene	66	<100	<10

SNA A standard is not available; the compound was searched using an NBS Library database of 42,000 compounds. The compound was not detected.

* Only one sample of RCRA Blend waste was taken. The results are repeated in each sample set.

Table 4-6 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #6 (Continued)

	Untreated Waste		Treated Waste	
Detected BDAT List Organic Constituents	K019 Concentration mg/kg (ppm)	RCRA Blend* Concentration mg/kg (ppm)	Kiln Ash Concentration mg/kg (ppm)	Kiln Ash TCLP mg/L (ppm)
SEMIVOLATILES (Continued)				
111. Hexachlorobutadiene	<50	210	<10	
113. Hexachloroethane	88	<100	<10	
121. Naphthalene	390	<20	<2	
126. Nitrobenzene	<25	3,400	<5	
136. Pentachlorobenzene	65	<100	<10	
141. Phenanthrene	17	240	<2	
142. Phenol	<10	78	<2	
145. Pyrene	<10	200	<2	
148. 1,2,4,5-Tetrachlorobenzene	86	<50	<5	
150. 1,2,4-Trichloroenzene	79	<50	<5	
Detected BDAT List Metal and Inorganic Constituents				
METALS				
154. Antimony	<6.0	24	9.6	< 0.06
155. Arsenic	<0.2	94	2.3	<0.002
156. Barium	<0.9	1.3	11	0.027
158. Cadmium	0.62	<0.3	2.2	0.006
159. Chromium	5.3	40	141	0.092
160. Copper	3.6	165	2,520	2.400
161. Lead	3.5	27	34	0.270
163. Nickel	6.0	8.8	288	0.690
165. Silver	<0.9	<0.9	3.1	<0.009
167. Vanadium	<2.0	2.2	8.7	<0.020
168. Zinc	8.4	4,170	13	0.061
INORGANICS				
169. Total Cyanide	<0.5	0.9	<0.47	
170. Fluoride	<5.0	31	4.7	
171. Sulfide	NA	830	92	

NA = Not Analyzed.

*Only one sample of RCRA Blend waste was taken. The results are repeated in each sample set.

Table 4-6 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - ROTARY KILN INCINERATOR

SAMPLE SET #6 (Continued)

DESIGN AND OPERATING PARAMETERS

Parameter	Design	Operating Value
Kiln Temperature (^{o}F)+	*	1775-1850
Kiln Solids Residence Time (min)	*	120
Waste Feed Rate (MMBTU/hr)+	*	K019: 11.5 RCRA Blend, Waste Burner #1: 5.2-5.8 RCRA Blend, Waste Burner #2: 5.2-9.7
Kiln Rotational Speed (RPM)	*	0.19-0.21

+Strip charts for this parameter are included in Appendix C.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 4-7

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #1

Detected BDAT List Organic Constituents	Untreated Waste Concentration				Treated Waste
	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
VOLATILES					
4. Benzene	<2,000	2,000	<2,000	17.0	<0.002
7. Carbon tetrachloride	4,000	<8	<2,000	1.90	<0.002
9. Chlorobenzene	3,000	<8	<2,000	<0.4	<0.002
14. Chloroform	4,600	<8	<2,000	<0.4	<0.002
21. Dichlorodifluoromethane	<200	<8	<2,000	<0.4	<0.002
22. 1,1-Dichloroethane	2,200	<8	<2,000	<0.4	<0.002
23. 1,2-Dichloroethane	93,000	<8	<2,000	<0.4	<0.002
34. Methyl ethyl ketone	<1,000	940	<10,000	3.5	<0.01
38. Methylene chloride	<1,000	910	<10,000	<2.0	<0.01
42. Tetrachloroethene	7,300	490	<2,000	<0.4	<0.002
43. Toluene	<200	2,300	41,000	3.7	<0.002
45. 1,1,1-Trichloroethane	81,000	130	<2,000	2.3	<0.002
47. Trichloroethene	3,210	360	3,600	<0.4	<0.002
215-217. Xylene (total)	<200	3,400	36,000	4.4	<0.002
222. Acetone	<1,000	1,200	<10,000	<2.0	<0.01
226. Ethyl benzene	<200	2,200	16,000	4.1	<0.002
229. Methyl isobutyl ketone	<1,000	1,100	<10,000	<2.0	<0.01
SEMIVOLATILES					
51. Acenaphthalene	<10	150	120	<0.002	<0.002
52. Acenaphthene	<10	<20	480	<0.002	<0.002
56. Aniline	<25	<50	<250	1.22	<0.005
57. Anthracene	<10	110	400	<0.002	<0.002
65. Benzo(k)fluoranthene	<10	67	<100	<0.002	<0.002
68. Bis(2-chloroethyl)ether	280	<20	<100	<0.002	<0.002
70. Bis(2-ethylhexyl)phthalate	<10	40	<100	0.079	<0.002

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-7 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #1 (Continued)

Detected BDAT List Organic Constituents	Untreated Waste Concentration K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Treated Waste Scrubber Water mg/L (ppm)
SEMIVOLATILES (Continued)					
80. Chrysene	SNA	28	<100	<0.002	<0.002
81. ortho-Cresol	<10	<20	<100	0.020	<0.002
87. o-Dichlorobenzene	<10	250	1,060	2.55	<0.002
88. p-Dichlorobenzene	81	32	460	0.260	<0.002
90. 2,4-Dichlorophenol	<25	<50	<250	0.420	<0.005
91. 2,6-Dichlorophenol	<25	<50	500	0.430	<0.005
98. Di-n-butyl phthalate	<10	31	120	0.012	<0.002
104. Di-n-octyl phthalate	<10	<20	430	<0.002	<0.002
108. Fluoranthene	<10	120	300	<0.002	<0.002
109. Fluorene	20	53	340	<0.002	<0.002
110. Hexachlorobenzene	69	<100	<500	0.022	<0.010
111. Hexachlorobutadiene	<50	210	<500	0.079	<0.010
113. Hexachloroethane	120	<100	<500	0.018	<0.010
121. Naphthalene	470	<20	400	0.133	<0.002
122. 1,4-Naphthoquinone	<10	<20	<100	0.078	<0.002
126. Nitrobenzene	<25	3,400	8,200	0.027	<0.005
136. Pentachlorobenzene	61	<100	1,000	0.020	<0.010
141. Phenanthrene	21	240	950	<0.002	<0.002
142. Phenol	<10	78	1,000	4.56	<0.002
145. Pyrene	<10	200	260	<0.002	<0.002
148. 1,2,4,5-Tetrachlorobenzene	76	<50	1,400	0.008	<0.005
150. 1,2,4-Trichlorobenzene	100	<50	19,000	1.24	<0.005
152. 2,4,6-Trichlorophenol	<50	<100	<500	0.037	<0.010

SNA A standard is not available; the compound was searched using an NBS Library data-base of 42,000 compounds. The compound was not detected.

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-7 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #1 (Continued)

Detected BDAT List Metal, Inorganic and PCB Constituents	Untreated Waste Concentration				Treated Waste
	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
METALS					
154. Antimony	<6.0	24	<41	<0.060	0.41
155. Arsenic	1.2	94	7.4	<0.020	0.046
156. Barium	0.97	1.3	<19	1.670	0.48
157. Beryllium	<0.1	<0.1	NA	<0.001	<0.001
158. Cadmium	0.63	<0.3	<33	<0.003	0.23
159. Chromium	4.0	40	23.7	<0.009	0.11
160. Copper	2.1	165	107	0.027	1.81
161. Lead	3.4	27	<7.3	0.0064	0.82
162. Mercury	<0.05	<0.05	<5.5	<0.001	0.002
163. Nickel	3.0	8.8	6.2	0.037	0.081
165. Silver	<0.9	<0.9	<18	0.018	0.085
167. Vanadium	<2.0	2.2	<2.6	<0.020	0.16
168. Zinc	5.8	4,170	6810	0.071	11.4
INORGANICS					
169. Total Cyanide	<0.5	0.9	<0.5	<0.010	<0.01
170. Fluoride	<5.0	31	15	0.950	20.0
171. Sulfide	790	830	16,000	17.0	<1.0
PCBs					
206. Aroclor 1260	NA	NA	33,500	NA	NA

NA Not Analyzed.

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-7 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #1 (Continued)

DESIGN AND OPERATING PARAMETERS	DESIGN	OPERATING VALUE++
Afterburner Temperature (^{o}F)+	*	2380
Residence Time (sec)	*	2
Waste Feed Rate (MMBTU/hr)+	*	PCB Blend Feed Rate: 36.1 Mercaptan-Contaminated Waste Feed Rate: 0.18
Excess Oxygen Concentration (%)+		6.8
Carbon Monoxide Concentration (ppm volume)		NR

NR Not Recorded.

+ Strip charts for this parameter are included in Appendix C.
++ See Tables 3-1 through 3-6 for K019 and RCRA Blend feed rates.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 4-8

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #2

tected BDAT List ganic Constituents	Untreated Waste Concentration				Treated Waste
	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
OLATILES					
4. Benzene	<2,000	2,000	<2,000	17.0	<0.002
7. Carbon tetrachloride	3,800	<8	<2,000	1.90	<0.002
9. Chlorobenzene	<2,000	<8	<2,000	<0.4	<0.002
14. Chloroform	5,800	<8	<2,000	<0.4	<0.002
21. Dichlorodifluoromethane	<2,000	<8	<2,000	<0.4	<0.002
22. 1,1-Dichloroethane	<2,000	<8	<2,000	<0.4	<0.002
23. 1,2-Dichloroethane	96,000	<8	<2,000	<0.4	<0.002
34. Methyl ethyl ketone	<10,000	940	<10,000	3.5	<0.010
38. Methylene chloride	<10,000	910	<10,000	<2.0	<0.010
42. Tetrachloroethene	6,700	490	<2,000	<0.4	<0.002
43. Toluene	<2,000	2,300	41,000	3.7	0.0032
45. 1,1,1-Trichloroethane	33,000	130	<2,000	2.3	<0.002
47. Trichloroethene	2,400	360	3,600	<0.4	<0.002
215-217. Xylene (total)	<2,000	3,400	36,000	4.4	<0.002
222. Acetone	<10,000	1,200	<10,000	<2.0	<0.01
226. Ethyl benzene	<2,000	2,200	16,000	4.1	<0.002
229. Methyl isobutyl ketone	<10,000	1,100	<10,000	<2.0	<0.01
SEMIVOLATILES					
51. Acenaphthalene	<10	150	120	<0.002	<0.002
52. Acenaphthene	<10	<20	480	<0.002	<0.002
56. Aniline	<25	<50	<250	1.22	<0.005
57. Anthracene	<10	110	400	<0.002	<0.002
65. Benzo(k)fluoranthene	<10	67	<100	<0.002	<0.002
68. Bis(2-chloroethyl)ether	280	<20	<100	<0.002	<0.002
70. Bis(2-ethylhexyl)phthalate	<10	40	<100	0.079	<0.002

* Only one sample of this waste type was taken. The results are repeated in each sample set.

[redacted]

Table 4-8 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #2 (Continued)

Detected BDAT List Organic Constituents	Untreated Waste Concentration: K019 mg/kg (ppm)	Untreated Waste Concentration: RCRA Blend* mg/kg (ppm)	Untreated Waste Concentration: PCB Blend* mg/kg (ppm)	Untreated Waste Concentration: Mercaptan-Contaminated Waste* mg/L (ppm)	Treated Waste: Scrubber Water mg/L (ppm)
SEMIVOLATILES (Continued)					
80. Chrysene	SNA	28	<100	<0.002	<0.002
81. ortho-Cresol	<10	<20	<100	0.020	<0.002
87. o-Dichlorobenzene	<10	250	1,060	2.55	<0.002
88. p-Dichlorobenzene	74	32	460	0.260	<0.002
90. 2,4-Dichlorophenol	<25	<50	<250	0.420	<0.005
91. 2,6-Dichlorophenol	<25	<50	500	0.430	<0.005
98. Di-n-butyl phthalate	<10	31	120	0.012	0.0063
104. Di-n-octyl phthalate	<10	<20	430	<0.002	<0.002
108. Fluoranthene	<10	120	300	<0.002	<0.002
109. Fluorene	16	53	340	<0.002	<0.002
110. Hexachlorobenzene	60	<100	<500	0.022	<0.010
111. Hexachlorobutadiene	<50	210	<500	0.079	<0.010
113. Hexachloroethane	85	<100	<500	0.018	<0.010
121. Naphthalene	314	<20	400	0.133	<0.002
122. 1,4-Naphthoquinone	<10	<20	<100	0.078	<0.002
126. Nitrobenzene	<25	3,400	8,200	0.027	<0.005
136. Pentachlorobenzene	51	<100	1,000	0.020	<0.010
141. Phenanthrene	15	240	950	<0.002	<0.002
142. Phenol	<10	78	1,000	4.56	<0.002
145. Pyrene	<10	200	260	<0.002	<0.002
148. 1,2,4,5-Tetrachlorobenzene	62	<50	1,400	0.008	<0.005
150. 1,2,4-Trichlorobenzene	65	<50	19,000	1.24	<0.005
152. 2,4,6-Trichlorophenol	<50	<100	<500	0.037	<0.010

SNA A standard is not available; the compound was searched using an NBS Library data-base of 42,000 compounds. The compound was not detected.

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-8 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #2 (Continued)

Detected BDAT List Metal, Inorganic and PCB Constituents	Untreated Waste Concentration				Treated Waste
	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
METALS					
154. Antimony	<6.0	24	<41	<0.060	0.39
155. Arsenic	<0.2	94	7.4	<0.020	0.038
156. Barium	<0.9	1.3	<19	1.670	0.50
157. Beryllium	<0.1	<0.1	NA	<0.001	<0.001
158. Cadmium	0.46	<0.3	<33	<0.003	0.19
159. Chromium	3.4	40	23.7	<0.009	0.14
160. Copper	1.7	165	107	0.027	1.38
161. Lead	2.3	27	<7.3	0.0064	0.78
162. Mercury	<0.05	<0.05	<5.5	<0.001	0.0026
163. Nickel	3.6	8.8	6.2	0.037	0.068
165. Silver	<0.9	<0.9	<18	0.018	0.095
167. Vanadium	<2.0	2.2	<2.6	<0.020	0.18
168. Zinc	6.9	4,170	6810	0.071	11.0
INORGANICS					
169. Total Cyanide	<0.5	0.9	<0.5	<0.010	<0.01
170. Fluoride	<5.0	31	15	0.950	15.0
171. Sulfide	NA	830	16,000	17.0	<1.0
PCBs					
206. Aroclor 1260	NA	NA	33,500	NA	NA

NA Not Analyzed.

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-8 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019 PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #2 (Continued)

DESIGN AND OPERATING PARAMETERS	DESIGN	OPERATING VALUE++
Afterburner Temperature (^{o}F)+	*	2400
Residence Time (sec)	*	2
Waste Feed Rate (MMBTU/hr)+	*	PCB Blend Feed Rate: 36.5 Mercaptan-Contaminated Waste Feed Rate: 0.18
Excess Oxygen Concentration (%)+		7.0
Carbon Monoxide Concentration (ppm volume)		NR

NR Not Recorded.

+ Strip charts for this parameter are included in Appendix C.
++ See Tables 3-1 through 3-6 for K019 and RCRA Blend feed rates.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 4-9

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #3

Detected BDAT List Organic Constituents	Untreated Waste Concentration				Treated Waste
	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
VOLATILES					
4. Benzene	<2,000	2,000	<2,000	17.0	<0.002
7. Carbon tetrachloride	3,500	<8	<2,000	1.90	<0.002
9. Chlorobenzene	<2,000	<8	<2,000	<0.4	<0.002
14. Chloroform	5.000	<8	<2,000	<0.4	<0.002
21. Dichlorodifluoromethane	<2,000	<8	<2,000	<0.4	0.0043
22. 1,1-Dichloroethane	<2,000	<8	<2,000	<0.4	<0.002
23. 1,2-Dichloroethane	87,000	<8	<2,000	<0.4	<0.002
34. Methyl ethyl ketone	<10,000	940	<10,000	3.5	<0.01
38. Methylene chloride	<10,000	910	<10,000	<2.0	<0.01
42. Tetrachloroethene	6,000	490	<2,000	<0.4	<0.002
43. Toluene	<2,000	2,300	41,000	3.7	0.0026
45. 1,1,1-Trichloroethane	34,000	130	<2,000	2.3	<0.002
47. Trichloroethene	2,200	360	3,600	<0.4	<0.002
215-217. Xylene (total)	<2,000	3,400	36,000	4.4	<0.002
222. Acetone	<10,000	1,200	<10,000	<2.0	<0.01
226. Ethyl benzene	<2,000	2,200	16,000	4.1	<0.002
229. Methyl isobutyl ketone	<10,000	1,100	<10,000	<2.0	<0.01
SEMIVOLATILES					
51. Acenaphthalene	<10	150	120	<0.002	<0.002
52. Acenaphthene	<10	<20	480	<0.002	<0.002
56. Aniline	<25	<50	<250	1.22	<0.005
57. Anthracene	<10	110	400	<0.002	<0.002
65. Benzo(k)fluoranthene	<10	67	<100	<0.002	<0.002
68. Bis(2-chloroethyl)ether	290	<20	<100	<0.002	<0.002
70. Bis(2-ethylhexyl)phthalate	<10	40	<100	0.079	<0.002

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-9 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #3 (Continued)

Detected BDAT List Organic Constituents	Untreated Waste Concentration: K019 mg/kg (ppm)	Untreated Waste Concentration: RCRA Blend* mg/kg (ppm)	Untreated Waste Concentration: PCB Blend* mg/kg (ppm)	Untreated Waste Concentration: Mercaptan-Contaminated Waste* mg/L (ppm)	Treated Waste: Scrubber Water mg/L (ppm)
SEMIVOLATILES (Continued)					
80. Chrysene	SNA	28	<100	<0.002	<0.002
81. ortho-Cresol	<10	<20	<100	0.020	<0.002
87. o-Dichlorobenzene	<10	250	1,060	2.55	<0.002
88. p-Dichlorobenzene	80	32	460	0.260	<0.002
90. 2,4-Dichlorophenol	<25	<50	<250	0.420	<0.002
91. 2,6-Dichlorophenol	<25	<50	500	0.430	<0.005
98. Di-n-butyl phthalate	<10	31	120	0.012	<0.005
104. Di-n-octyl phthalate	<10	<20	430	<0.002	0.0046
108. Fluoranthene	<10	120	300	<0.002	<0.002
109. Fluorene	19	53	340	<0.002	<0.002
110. Hexachlorobenzene	73	<100	<500	0.022	<0.002
111. Hexachlorobutadiene	<50	210	<500	0.079	<0.01
113. Hexachloroethane	95	<100	<500	0.018	<0.01
121. Naphthalene	350	<20	400	0.133	<0.01
122. 1,4-Naphthoquinone	<10	<20	<100	0.078	<0.002
126. Nitrobenzene	<25	3,400	8,200	0.027	<0.002
136. Pentachlorobenzene	59	<100	1,000	0.020	<0.005
141. Phenanthrene	11	240	950	<0.002	<0.010
142. Phenol	<10	78	1,000	4.56	<0.002
145. Pyrene	<10	200	260	<0.002	<0.002
148. 1,2,4,5-Tetrachlorobenzene	67	<50	1,400	0.008	<0.002
150. 1,2,4-Trichlorobenzene	70	<50	19,000	1.240	<0.005
152. 2,4,6-Trichlorophenol	<50	<100	<500	0.037	<0.005

SNA A standard is not available; the compound was searched using an NBS Library data-base of 42,000 compounds. The compound was not detected.

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-9 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #3 (Continued)

	Untreated Waste Concentration				Treated Waste
Detected BDAT List Metal, Inorganic and PCB Constituents	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
METALS					
154. Antimony	<6.0	24	<41	<0.060	0.41
155. Arsenic	<0.2	94	7.4	<0.02	0.030
156. Barium	<0.9	1.3	<19	1.670	0.530
157. Beryllium	<0.1	<0.1	NA	<0.001	<0.001
158. Cadmium	0.53	<0.3	<33	<0.003	0.150
159. Chromium	3.5	40	23.7	<0.009	0.13
160. Copper	1.7	165	107	0.027	1.18
161. Lead	3.4	27	<7.3	0.0064	0.64
162. Mercury	<0.05	<0.05	<5.5	<0.001	0.0015
163. Nickel	2.3	8.8	6.2	0.037	0.057
165. Silver	<0.9	<0.9	<18	0.018	0.0092
167. Vanadium	<2.0	2.2	<2.6	<0.020	0.150
168. Zinc	4.4	4,170	6810	0.071	9.50
INORGANICS					
169. Total Cyanide	<0.5	0.9	<0.5	<0.010	<0.01
170. Fluoride	<5.0	31	15	0.950	14.0
171. Sulfide	NA	830	16,000	17.0	<1.0
PCBs					
206. Arochlor 1260	NA	NA	33,500	NA	NA

NA Not Analyzed.

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-9 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #3 (Continued)

DESIGN AND OPERATING PARAMETERS	DESIGN	OPERATING VALUE++
Afterburner Temperature (°F)+	*	2400
Residence Time (sec)	*	2
Waste Feed Rate (MMBTU/hr)+	*	PCB Blend Feed Rate: 36.5 Mercaptan-Contaminated Waste Feed Rate: 0.18
Excess Oxygen Concentration (%)+		7.2
Carbon Monoxide Concentration (ppm volume)+		0

+ Strip charts for this parameter are included in Appendix C.
++ See Tables 3-1 through 3-6 for K019 and RCRA Blend feed rates.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 4-10

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #4

	Untreated Waste Concentration				Treated Waste
Detected BDAT List Organic Constituents	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
VOLATILES					
4. Benzene	<2,000	2,000	<2,000	17.0	<0.002
7. Carbon tetrachloride	3,900	<8	<2,000	1.90	<0.002
9. Chlorobenzene	<2,000	<8	<2,000	<0.4	<0.002
14. Chloroform	5,300	<8	<2,000	<0.4	<0.002
21. Dichlorodifluoromethane	<2,000	<8	<2,000	<0.4	0.014
22. 1,1-Dichloroethane	<2,000	<8	<2,000	<0.4	<0.002
23. 1,2-Dichloroethane	122,000	<8	<2,000	<0.4	<0.002
34. Methyl ethyl ketone	<10,000	940	<10,000	3.5	<0.01
38. Methylene chloride	<10,000	910	<10,000	<2.0	<0.01
42. Tetrachloroethene	7,200	490	<2,000	<0.4	<0.002
43. Toluene	<2,000	2,300	41,000	3.7	0.0046
45. 1,1,1-Trichloroethane	44,000	130	<2,000	2.3	<0.002
47. Trichloroethene	2,300	360	3,600	<0.4	<0.002
215-217. Xylene (total)	<2,000	3,400	36,000	4.4	<0.002
222. Acetone	<10,000	1,200	<10,000	<2.0	<0.01
226. Ethyl benzene	<2,000	2,200	16,000	4.1	<0.002
229. Methyl isobutyl ketone	<10,000	1,100	<10,000	<2.0	<0.01
SEMIVOLATILES					
51. Acenaphthalene	<10	150	120	<0.002	<0.002
52. Acenaphthene	<10	<20	480	<0.002	<0.002
56. Aniline	<25	<50	<250	1.22	<0.005
57. Anthracene	<10	110	400	<0.002	<0.002
65. Benzo(k)fluoranthene	<10	67	<100	<0.002	<0.002
68. Bis(2-chloroethyl)ether	310	<20	<100	<0.002	<0.002
70. Bis(2-ethylhexyl)phthalate	<10	40	<100	0.079	<0.002

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-10 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #4 (Continued)

Detected BDAT List Organic Constituents	Untreated Waste Concentration				Treated Waste
	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
SEMIVOLATILES (Continued)					
80. Chrysene	SNA	28	<100	<0.002	<0.002
81. ortho-Cresol	<10	<20	<100	0.020	<0.002
87. o-Dichlorobenzene	<10	250	1,060	2.55	<0.002
88. p-Dichlorobenzene	84	32	460	0.260	<0.002
90. 2,4-Dichlorophenol	<25	<50	<250	0.420	<0.005
91. 2,6-Dichlorophenol	<25	<50	500	0.430	<0.005
98. Di-n-butyl phthalate	<10	31	120	0.012	0.0042
104. Di-n-octyl phthalate	<10	<20	430	<0.002	<0.002
108. Fluoranthene	<10	120	300	<0.002	<0.002
109. Fluorene	21	53	340	<0.002	<0.002
110. Hexachlorobenzene	61	<100	<500	0.022	<0.010
111. Hexachlorobutadiene	<50	210	<500	0.079	<0.010
113. Hexachloroethane	94	<100	<500	0.018	<0.010
121. Naphthalene	360	<20	400	0.133	<0.002
122. 1,4-Naphthoquinone	<10	<20	<100	0.078	<0.002
126. Nitrobenzene	<25	3,400	8,200	0.027	<0.005
136. Pentachlorobenzene	64	<100	1,000	0.020	<0.010
141. Phenanthrene	19	240	950	<0.002	<0.002
142. Phenol	<10	78	1,000	4.56	<0.002
145. Pyrene	<10	200	260	<0.002	<0.002
148. 1,2,4,5-Tetrachlorobenzene	82	<50	1,400	0.008	<0.005
150. 1,2,4-Trichlorobenzene	74	<50	19,000	1.240	<0.005
152. 2,4,6-Trichlorophenol	<50	<100	<500	0.037	<0.010

SNA A standard is not available; the compound was searched using an NBS Library data-base of 42,000 compounds. The compound was not detected.

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-10 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #4 (Continued)

Detected BDAT List Metal, Inorganic and PCB Constituents	Untreated Waste Concentration				Treated Waste
	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
METALS					
154. Antimony	<6.0	24	<41	<0.060	0.4
155. Arsenic	<0.2	94	7.4	<0.020	0.029
156. Barium	<0.9	1.3	<19	1.670	0.55
157. Beryllium	<0.1	<0.1	NA	<0.001	<0.001
158. Cadmium	<0.3	<0.3	<33	<0.003	0.13
159. Chromium	1.8	40	23.7	<0.009	0.14
160. Copper	<1.0	165	107	0.027	1.13
161. Lead	2.4	27	<7.3	0.0064	0.600
162. Mercury	<0.05	<0.05	<5.5	<0.001	0.0004
163. Nickel	2.2	8.8	6.2	0.037	0.065
165. Silver	<0.9	<0.9	<18	0.018	0.092
167. Vanadium	<2.0	2.2	<2.6	<0.020	0.150
168. Zinc	9.4	4,170	6810	0.071	9.98
INORGANICS					
169. Total Cyanide	<0.5	0.9	<0.5	<0.010	<0.01
170. Fluoride	5.0	31	15	0.950	13.0
171. Sulfide	NA	830	16,000	17.0	<1.0
PCBs					
206. Aroclor 1260	NA	NA	33,500	NA	NA

NA Not Analyzed.

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-10 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #4 (Continued)

DESIGN AND OPERATING PARAMETERS	DESIGN	OPERATING VALUE++
Afterburner Temperature (°F)+	*	2400
Residence Time (sec)	*	2
Waste Feed Rate (MMBTU/hr)+	*	PCB Blend Feed Rate: 36.5 Mercaptan-Contaminated Waste Feed Rate: 0.18
Excess Oxygen Concentration (%)+		6.4
Carbon Monoxide Concentration (ppm volume)+		0

+ Strip charts for this parameter are included in Appendix C.

++ See Tables 3-1 through 3-6 for K019 and RCRA Blend feed rates.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 4-11

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #5

Detected BDAT List Organic Constituents	Untreated Waste Concentration				Treated Waste
	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
VOLATILES					
4. Benzene	<2,000	2,000	<2,000	17.0	<0.002
7. Carbon tetrachloride	4,000	<8	<2,000	1.90	<0.002
9. Chlorobenzene	<2,000	<8	<2,000	<0.4	<0.002
14. Chloroform	6,000	<8	<2,000	<0.4	<0.002
21. Dichlorodifluoromethane	<2,000	<8	<2,000	<0.4	<0.002
22. 1,1-Dichloroethane	<2,000	<8	<2,000	<0.4	<0.002
23. 1,2-Dichloroethane	130,000	<8	<2,000	<0.4	<0.002
34. Methyl ethyl ketone	<10,000	940	<10,000	3.5	<0.01
38. Methylene chloride	<10,000	910	<10,000	<2.0	<0.01
42. Tetrachloroethene	7,800	490	<2,000	<0.4	<0.002
43. Toluene	<2,000	2,300	41,000	3.7	<0.002
45. 1,1,1-Trichloroethane	45,000	130	<2,000	2.3	<0.002
47. Trichloroethene	2,500	360	3,600	<0.4	<0.002
215-217. Xylene (total)	<2,000	3,400	36,000	4.4	<0.002
222. Acetone	<10,000	1,200	<10,000	<2.0	<0.01
226. Ethyl benzene	<2,000	2,200	16,000	4.1	<0.002
229. Methyl isobutyl ketone	<10,000	1,100	<10,000	<2.0	<0.01
SEMIVOLATILES					
51. Acenaphthalene	<10	150	120	<0.002	<0.002
52. Acenaphthene	<10	<20	480	<0.002	<0.002
56. Aniline	<25	<50	<250	1.22	<0.005
57. Anthracene	<10	110	400	<0.002	<0.002
65. Benzo(k)fluoranthene	<10	67	<100	<0.002	<0.002
68. Bis(2-chloroethyl)ether	340	<20	<100	<0.002	<0.002
70. Bis(2-ethylhexyl)phthalate	<10	40	<100	0.079	<0.002

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-11 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #5 (Continued)

Detected BDAT List Organic Constituents	Untreated Waste Concentration: K019 mg/kg (ppm)	Untreated Waste Concentration: RCRA Blend* mg/kg (ppm)	Untreated Waste Concentration: PCB Blend* mg/kg (ppm)	Untreated Waste Concentration: Mercaptan-Contaminated Waste* mg/L (ppm)	Treated Waste: Scrubber Water mg/L (ppm)
SEMIVOLATILES (Continued)					
80. Chrysene	SNA	28	<100	<0.002	<0.002
81. ortho-Cresol	<10	<20	<100	0.020	<0.002
87. o-Dichlorobenzene	<10	250	1,060	2.55	<0.002
88. p-Dichlorobenzene	90	32	460	0.260	<0.002
90. 2,4-Dichlorophenol	<25	<50	<250	0.420	<0.005
91. 2,6-Dichlorophenol	<25	<50	500	0.430	<0.005
98. Di-n-butyl phthalate	<10	31	120	0.012	0.0027
104. Di-n-octyl phthalate	<10	<20	430	<0.002	<0.002
108. Fluoranthene	<10	120	300	<0.002	<0.002
109. Fluorene	19	53	340	<0.002	<0.002
110. Hexachlorobenzene	87	<100	<500	0.022	<0.01
111. Hexachlorobutadiene	<50	210	<500	0.079	<0.01
113. Hexachloroethane	113	<100	<500	0.018	<0.01
121. Naphthalene	371	<20	400	0.133	<0.002
122. 1,4-Naphthoquinone	<10	<20	<100	0.078	<0.002
126. Nitrobenzene	<25	3,400	8,200	0.027	<0.005
136. Pentachlorobenzene	63	<100	1,000	0.020	<0.01
141. Phenanthrene	19	240	950	<0.002	<0.002
142. Phenol	<10	78	1,000	4.56	<0.002
145. Pyrene	<10	200	260	<0.002	<0.002
148. 1,2,4,5-Tetrachlorobenzene	73	<50	1,400	0.008	<0.005
150. 1,2,4-Trichlorobenzene	72	<50	19,000	1.240	<0.005
152. 2,4,6-Trichlorophenol	<50	<100	<500	0.037	<0.010

SNA A standard is not available; the compound was searched using an NBS Library data-base of 42,000 compounds. The compound was not detected.

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-11 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #5 (Continued)

	Untreated Waste Concentration				Treated Waste
Detected BDAT List Metal, Inorganic and PCB Constituents	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
METALS					
154. Antimony	<6.0	24	<41	<0.060	0.35
155. Arsenic	<0.2	94	7.4	<0.020	0.027
156. Barium	<0.9	1.3	<19	1.670	0.600
157. Beryllium	<0.1	<0.1	NA	<0.001	0.002
158. Cadmium	0.36	<0.3	<33	<0.003	0.12
159. Chromium	3.2	40	23.7	<0.009	0.14
160. Copper	2.1	165	107	0.027	1.03
161. Lead	2.5	27	<7.3	0.0064	0.48
162. Mercury	<0.05	<0.05	<5.5	<0.001	0.001
163. Nickel	4.8	8.8	6.2	0.037	0.067
165. Silver	<0.9	<0.9	<18	0.018	0.090
167. Vanadium	<2.0	2.2	<2.6	<0.020	0.160
168. Zinc	4.7	4,170	6810	0.071	11.1
INORGANICS					
169. Total Cyanide	<0.5	0.9	<0.5	<0.010	<0.01
170. Fluoride	<5.0	31	15	0.950	12.0
171. Sulfide	NA	830	16,000	17.0	<1.0
PCBs					
206. Aroclor 1260	NA	NA	33,500	NA	NA

NA Not Analyzed.

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-11 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019 PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #5 (Continued)

DESIGN AND OPERATING PARAMETERS	DESIGN	OPERATING VALUE++
Afterburner Temperature (^{o}F)+	*	2400
Residence Time (sec)	*	2
Waste Feed Rate (MMBTU/hr)+	*	PCB Blend Feed Rate: 37.5 Mercaptan-Contaminated Waste Feed Rate: 0.18
Excess Oxygen Concentration (%)+		6.8
Carbon Monoxide Concentration (ppm volume)		NR

NR Not Recorded.

+ Strip charts for this parameter are included in Appendix C.
++ See Tables 3-1 through 3-6 for K019 and RCRA Blend feed rates.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 4-12

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #6

Detected BDAT List Organic Constituents	Untreated Waste Concentration				Treated Waste
	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
VOLATILES					
4. Benzene	<2,000	2,000	<2,000	17.0	<0.002
7. Carbon tetrachloride	4,100	<8	<2,000	1.90	<0.002
9. Chlorobenzene	<2,000	<8	<2,000	<0.4	<0.002
14. Chloroform	5,600	<8	<2,000	<0.4	<0.002
21. Dichlorodifluoromethane	<2,000	<8	<2,000	<0.4	<0.002
22. 1,1-Dichloroethane	<2,000	<8	<2,000	<0.4	<0.002
23. 1,2-Dichloroethane	98,000	<8	<2,000	<0.4	<0.002
34. Methyl ethyl ketone	<10,000	940	<10,000	3.5	<0.01
38. Methylene chloride	<10,000	910	<10,000	<2.0	<0.01
42. Tetrachloroethene	6,900	490	<2,000	<0.4	<0.002
43. Toluene	<2,000	2,300	41,000	3.7	<0.002
45. 1,1,1-Trichloroethane	44,000	130	<2,000	2.3	<0.002
47. Trichloroethene	2,500	360	3,600	<0.4	<0.002
215-217. Xylene (total)	<2,000	3,400	36,000	4.4	<0.002
222. Acetone	<10,000	1,200	<10,000	<2.0	<0.01
226. Ethyl benzene	<2,000	2,200	16,000	4.1	<0.002
229. Methyl isobutyl ketone	<10,000	1,100	<10,000	<2.0	<0.01
SEMIVOLATILES					
51. Acenaphthalene	<10	150	120	<0.002	<0.002
52. Acenaphthene	<10	<20	480	<0.002	<0.002
56. Aniline	<25	<50	<250	1.22	<0.005
57. Anthracene	<10	110	400	<0.002	<0.002
65. Benzo(k)fluoranthene	<10	67	<100	<0.002	<0.002
68. Bis(2-chloroethyl)ether	330	<20	<100	<0.002	<0.002
70. Bis(2-ethylhexyl)phthalate	<10	40	<100	0.079	<0.002

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-12 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #6 (Continued)

	Untreated Waste Concentration				Treated Waste
Detected BDAT List Organic Constituents	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
SEMIVOLATILES (Continued)					
80. Chrysene	SNA	28	<100	<0.002	<0.002
81. ortho-Cresol	<10	<20	<100	0.020	<0.002
87. o-Dichlorobenzene	<10	250	1,060	2.55	<0.002
88. p-Dichlorobenzene	90	32	460	0.260	<0.002
90. 2,4-Dichlorophenol	<25	<50	<250	0.420	<0.005
91. 2,6-Dichlorophenol	<25	<50	500	0.430	<0.005
98. Di-n-butyl phthalate	<10	31	120	0.012	0.0025
104. Di-n-octyl phthalate	<10	<20	430	<0.002	<0.002
108. Fluoranthene	<10	120	300	<0.002	<0.002
109. Fluorene	22	53	340	<0.002	<0.002
110. Hexachlorobenzene	66	<100	<500	0.022	<0.01
111. Hexachlorobutadiene	<50	210	<500	0.079	<0.01
113. Hexachloroethane	88	<100	<500	0.018	<0.01
121. Naphthalene	390	<20	400	0.133	<0.002
122. 1,4-Naphthoquinone	<10	<20	<100	0.078	<0.002
126. Nitrobenzene	<25	3,400	8,200	0.027	<0.005
136. Pentachlorobenzene	65	<100	1,000	0.020	<0.01
141. Phenanthrene	17	240	950	<0.002	<0.002
142. Phenol	<10	78	1,000	4.56	<0.002
145. Pyrene	<10	200	260	<0.002	<0.002
148. 1,2,4,5-Tetrachlorobenzene	86	<50	1,400	0.008	<0.005
150. 1,2,4-Trichlorobenzene	79	<50	19,000	1.24	<0.005
152. 2,4,6-Trichlorophenol	<50	<100	<500	0.037	<0.01

SNA A standard is not available; the compound was searched using an NBS Library data-base of 42,000 compounds. The compound was not detected.

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-12 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #6 (Continued)

Detected BDAT List Metal, Inorganic and PCB Constituents	Untreated Waste Concentration				Treated Waste
	K019 mg/kg (ppm)	RCRA Blend* mg/kg (ppm)	PCB Blend* mg/kg (ppm)	Mercaptan-Contaminated Waste* mg/L (ppm)	Scrubber Water mg/L (ppm)
METALS					
154. Antimony	<6.0	24	<41	<0.060	0.32
155. Arsenic	<0.2	94	7.4	<0.020	0.033
156. Barium	<0.9	1.3	<19	1.670	0.57
157. Beryllium	<0.1	<0.1	NA	<0.001	<0.001
158. Cadmium	0.62	<0.3	<33	<0.003	0.11
159. Chromium	5.3	40	23.7	<0.009	0.13
160. Copper	3.6	165	107	0.027	0.87
161. Lead	3.5	27	<7.3	0.0064	0.4
162. Mercury	<0.05	<0.05	<5.5	<0.001	0.001
163. Nickel	6.0	8.8	6.2	0.037	0.061
165. Silver	<0.9	<0.9	<18	0.018	0.092
167. Vanadium	<2.0	2.2	<2.6	<0.020	0.16
168. Zinc	8.4	4,170	6810	0.071	10.4
INORGANICS					
169. Total Cyanide	<0.5	0.9	<0.5	<0.010	<0.01
170. Fluoride	<5.0	31	15	0.950	12.0
171. Sulfide	NA	830	16,000	17.0	<1.0
PCBs					
206. Aroclor 1260	NA	NA	33,500	NA	NA

NA Not Analyzed.

* Only one sample of this waste type was taken. The results are repeated in each sample set.

Table 4-12 (Continued)

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K019
PLANT A - COMBUSTION GAS SCRUBBER TREATMENT SYSTEM

SAMPLE SET #6 (Continued)

DESIGN AND OPERATING PARAMETERS	DESIGN	OPERATING VALUE++
Afterburner Temperature (^{o}F)+	*	2350
Residence Time (sec)	*	2
Waste Feed Rate (MMBTU/hr)+	*	PCB Blend Feed Rate: 37.5 Mercaptan-Contaminated Waste Feed Rate: 0.18
Excess Oxygen Concentration (%)+		7.0
Carbon Monoxide Concentration (ppm volume)		NR

NR Not Recorded.

+ Strip charts for this parameter are included in Appendix C.
++ See Tables 3-1 through 3-6 for K019 and RCRA Blend feed rates.

*This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

Table 4-13

TREATMENT PERFORMANCE DATA SUBMITTED BY INDUSTRY FOR CHLORINATED WASTES*
PLANT B - FLUIDIZED BED INCINERATOR

TEST RUN 1

Constituent	Untreated Waste* Sludge Waste Feed Concentration mg/kg (ppm)	Liquid Waste Feed Concentration mg/kg (ppm)	Solid Waste Feed Concentration mg/kg (ppm)	Treated Waste Incinerator Ash Concentration mg/kg (ppm)	Scrubber Water Total Concentration mg/L (ppm)
Condition I**					
7. Carbon tetrachloride	12,000	256,000	NS	0.0066	<0.001
42. Tetrachloroethene	95,000	444,000	NS	0.128	<0.001
88. p-Dichlorobenzene	4,900	296,000	NS	0.0065	<0.002
Inlet Feed Rate (lbs/hr)	2,441	102	NS	--	--
Residence time in SRC (Sec)	3.2				
Condition II**					
7. Carbon tetrachloride	2,000	262,000	<0.5	<0.001	<0.001
42. Tetrachloroethene	60,000	440,000	<0.5	<0.001	<0.001
88. p-Dichlorobenzene	1,000	294,000	<1.5	0.014	<0.002
Inlet Feed Rate (lbs/hr)	1,564	121.5	1,638	--	--
Residence time in SRC (Sec)	4.8				
Condition III**					
7. Carbon tetrachloride	12,000	249,000	NS	<0.001	<0.001
42. Tetrachloroethene	88,000	441,000	NS	0.0052	<0.001
88. p-Dichlorobenzene	6,200	289,000	NS	0.061	<0.002
Inlet Feed Rate (lbs/hr)	1,883	117.2	NS	--	--
Residence time in SRC (Sec)	3.2				
Condition IV**					
7. Carbon tetrachloride	9,000	252,000	<0.5	<0.001	<0.001
42. Tetrachloroethene	70,000	444,000	<0.5	0.008	<0.001
88. p-Dichlorobenzene	4,100	297,000	<1.5	0.008	<0.002
Inlet Feed Rate (lbs/hr)	1,371	68.5	980	--	--
Residence time in SRC (Sec)	4.8				

SRC = Secondary Reaction Chamber
NS = Not Sampled for this condition.

*These wastes were generated from the production of vinyl chloride monomer, trichloroethylene, and perchloroethylene. Information specific to the sources or identities of the wastes were not provided.

**The inlet feed rate of untreated wastes and the residence time of materials in the SRC varied for the four "conditions." The fluidized bed incinerator was operated at an average temperature of 788°C (1451°F).

Source: References 18, 19, 20, and 21.

Table 4-14

TREATMENT PERFORMANCE DATA SUBMITTED BY INDUSTRY FOR CHLORINATED WASTES*
PLANT B - FLUIDIZED BED INCINERATOR

TEST RUN 2

	Untreated Waste*			Treated Waste	
Constituent	Sludge Waste Feed Concentration mg/kg (ppm)	Liquid Waste Feed Concentration mg/kg (ppm)	Solid Waste Feed Concentration mg/kg (ppm)	Incinerator Ash Concentration mg/kg (ppm)	Scrubber Water Total Concentration mg/L (ppm)
Condition I**					
7. Carbon tetrachloride	12,000	260,000	NS	<0.001	<0.001
42. Tetrachloroethene	94,000	444,000	NS	0.0169	<0.001
88. p-Dichlorobenzene	5,600	303,000	NS	0.0093	<0.002
Inlet Feed Rate (lbs/hr)	2,448	53.9	NS	--	--
Residence time in SRC (Sec)	3.2				
Condition II**					
7. Carbon tetrachloride	2,000	261,000	<0.5	<0.001	<0.001
42. Tetrachloroethene	60,000	440,000	<0.5	0.0015	<0.001
88. p-Dichlorobenzene	1,000	300,000	<1.5	0.022	<0.002
Inlet Feed Rate (lbs/hr)	1,352	133.9	1,638	--	--
Residence time in SRC (Sec)	4.8				
Condition III**					
7. Carbon tetrachloride	12,000	251,000	NS	<0.001	<0.001
42. Tetrachloroethene	93,000	442,000	NS	0.0052	<0.001
88. p-Dichlorobenzene	7,100	295,000	NS	0.197	<0.002
Inlet Feed Rate (lbs/hr)	1,882	142	NS	--	--
Residence time in SRC (Sec)	3.2				
Condition IV**					
7. Carbon tetrachloride	11,000	252,000	<0.5	<0.001	<0.001
42. Tetrachloroethene	83,000	444,000	<0.5	0.0058	<0.001
88. p-Dichlorobenzene	5,300	295,000	<1.5	0.0064	<0.002
Inlet Feed Rate (lbs/hr)	1,383	76.8	980	--	--
Residence time in SRC (Sec)	4.8				

SRC = Secondary Reaction Chamber
NS = Not Sampled for this condition.

*These wastes were generated from the production of vinyl chloride monomer, trichloroethylene, and perchloroethylene. Information specific to the sources or identities of the wastes were not provided.

**The inlet feed rate of untreated wastes and the residence time of materials in the SRC varied for the four "conditions." The fluidized bed incinerator was operated at an average temperature of 788°C (1451°F).

Source: References 18, 19, 20, and 21.

Table 4-15

TREATMENT PERFORMANCE DATA SUBMITTED BY INDUSTRY FOR CHLORINATED WASTES*
PLANT B - FLUIDIZED BED INCINERATOR

TEST RUN 3

Constituent	Untreated Waste*: Sludge Waste Feed Concentration mg/kg (ppm)	Untreated Waste*: Liquid Waste Feed Concentration mg/kg (ppm)	Untreated Waste*: Solid Waste Feed Concentration mg/kg (ppm)	Treated Waste: Incinerator Ash Concentration mg/kg (ppm)	Treated Waste: Scrubber Water Total Concentration mg/L (ppm)
Condition I**					
7. Carbon tetrachloride	10,000	260,000	NS	<0.001	<0.001
42. Tetrachloroethene	81,000	445,000	NS	0.0072	<0.001
88. p-Dichlorobenzene	4,900	298,000	NS	0.0039	<0.002
Inlet Feed Rate (lbs/hr)	2,565	67.8	NS	--	--
Residence time in SRC (Sec)	3.2				
Condition II**					
7. Carbon tetrachloride	13,000	259,000	<0.5	<0.001	<0.001
42. Tetrachloroethene	95,000	447,000	<0.5	<0.002	<0.001
88. p-Dichlorobenzene	6,500	304,000	<1.5	0.0145	<0.002
Inlet Feed Rate (lbs/hr)	1,742	96.8	1,638	--	--
Residence time in SRC (Sec)	4.8				
Condition III**					
7. Carbon tetrachloride	15,000	254,000	NS	<0.001	<0.001
42. Tetrachloroethene	94,000	441,000	NS	0.0091	<0.001
88. p-Dichlorobenzene	7,500	294,000	NS	0.1	<0.002
Inlet Feed Rate (lbs/hr)	2,083	95.1	NS	--	--
Residence time in SRC (Sec)	3.2				
Condition IV**					
7. Carbon tetrachloride	10,000	252,000	<0.5	<0.001	<0.001
42. Tetrachloroethene	77,000	444,000	<0.5	0.0057	<0.001
88. p-Dichlorobenzene	4,600	294,000	<1.5	0.011	<0.002
Inlet Feed Rate (lbs/hr)	1,294	68.5	980	--	--
Residence time in SRC (Sec)	4.8				

SRC = Secondary Reaction Chamber
NS = Not Sampled for this condition.

*These wastes were generated from the production of vinyl chloride monomer, trichloroethylene, and perchloroethylene. Information specific to the sources or identities of the wastes were not provided.

**The inlet feed rate of untreated wastes and the residence time of materials in the SRC varied for the four "conditions." The fluidized bed incinerator was operated at an average temperature of 788°C (1451°F).

Source: References 18, 19, 20, and 21.

5.0 IDENTIFICATION OF BEST DEMONSTRATED AND AVAILABLE TECHNOLOGY

This section presents the rationale behind the determination of rotary kiln incineration as the best demonstrated and available technology (BDAT) for the chlorinated waste group (K016, K018, K019, K020, and K030).

In Section 3.0 of this document, the Agency identified three types of incineration as demonstrated and available technology to be considered for BDAT for the chlorinated waste group (K016, K018, K019, K020, and K030). The three types of incineration are: rotary kiln incineration, fluidized bed incineration, and liquid injection incineration.

As described in Section 1.0, BDAT for treatment of these wastes is identified based on treatment performance data available to the Agency. (All performance data available to the Agency are discussed in Section 4.0.) Prior to being used to establish treatment standards, performance data are screened to determine whether they represent operation of a well-designed and operated system, whether sufficient analytical quality assurance/quality control measures were employed to ensure the accuracy of the data, and whether the appropriate measure of performance was used to assess the performance of the particular treatment technology, i.e., total constituent concentration in the case of incineration. All remaining data are then adjusted based on recovery data in order to take into account analytical interferences associated with the chemical make-up of the samples. Finally, treatment performance data from each technology are compared (technology to technology), to determine whether any technology performs better than the others.

5.1 Review of Performance Data

The available treatment performance data presented in Section 4.0 were reviewed and assessed to determine whether they represent operation of a well-designed and operated system, whether sufficient quality assurance/quality control measures were employed to ensure the accuracy of the data, and whether the appropriate measure of performance was used to assess the performance of the treatment technology.

The treatment performance data and the design and operating data collected during the test on the rotary kiln incineration of K019 at plant A were reviewed. The appropriate measure of performance (total constituent concentration) was used to assess the rotary kiln incineration system. Additionally, the Agency had no reason to believe that the treatment system at plant A was not well-designed and well-operated or that insufficient analytical quality assurance/quality control measures were employed. Therefore, these data were considered in the determination of BDAT.

The treatment performance data and the operating data for fluidized bed incineration of chlorinated wastes (submitted by plant B) were reviewed. The appropriate measure of performance (total constituent concentration) was used to assess the fluidized bed incineration system. Additionally, the Agency had no reason to believe that the treatment system at plant B was not well-designed and well-operated or that insufficient analytical quality assurance/quality control measures were employed. However, the Agency has no information specific to the sources and thus, the identity of the untreated wastes fed to the fluidized bed incinerator. Furthermore, the Agency does not have sufficient raw waste characterization data to determine that these untreated wastes are similar to K016, K018-K020, K030. In addition, the Agency has no reason to expect that fluidized bed incineration will provide better treatment than rotary kiln incineration for K016, K018, K019, K020, and K030 waste. However, the Agency believes that K016, K018, K019, K020, or K030 wastes treated in a well-designed and operated fluidized bed incineration system will meet the BDAT treatment standards established for these wastes. Therefore, these data were not considered in the determination of BDAT.

As discussed in Section 3.0, treatment performance data are not available for liquid injection incineration for the chlorinated waste group (K016, K018, K019, K020, and K030). Therefore, in the absence of treatment performance data for these wastes or wastes judged to be similar, liquid injection incineration was considered and ultimately rejected as BDAT for the chlorinated waste group (K016, K018, K019, K020, and K030). However, the Agency believes that a well designed and operated liquid injection incineration system will meet the BDAT treatment standards established for this waste group.

5.2 Accuracy Correction of Performance Data

Following the review of all available treatment performance data, the remaining treatment performance data for the demonstrated and available technology (rotary kiln incineration) were adjusted in order to take into account analytical interferences associated with the chemical make-up of the samples. Generally, performance data were corrected for accuracy as follows: (1) a matrix spike recovery was determined, as explained below, for each BDAT List constituent detected in the untreated or treated waste; (2) an accuracy correction factor was determined for each of the above constituents by dividing 100 by the matrix spike recovery (in percent) for that constituent; and (3) treatment performance data for each BDAT List constituent detected in the untreated or treated waste were corrected by multiplying the reported concentration of the constituent by the corresponding accuracy correction factor.

Matrix spike recoveries are developed by analyzing a sample of a treated waste for a constituent and then re-analyzing the sample after the addition of a known amount of the same constituent (i.e., spike) to the sample. The matrix spike recovery represents the total amount of constituent recovered after spiking minus the initial concentration of the constituent in the sample, and the result divided by the known amount of constituent added.

5.2.1 Nonwastewater

Matrix spike recoveries used in adjustment of the treatment performance data for the kiln ash residue are presented in Table D-4 of Appendix D of this background document. Duplicate matrix spikes were performed for some BDAT List volatile and semivolatile constituents in kiln ash. If duplicate matrix spikes were performed for an organic constituent, the matrix spike recovery used for that constituent was the lower of the two values from the first matrix spike and the duplicate spike.

Where a matrix spike was not performed for an organic constituent, the matrix spike recovery for that constituent was derived from the average matrix spike recoveries of the appropriate group of constituents (volatile or semivolatile constituents) for which recovery data were available. In these cases, the matrix spike recoveries for all volatiles or semivolatiles from the first matrix spike were averaged. Similarly, an average matrix spike recovery was calculated for the duplicate matrix spike recoveries. The lower of the two average matrix spike recoveries of the volatile or semivolatile group was used for any volatile or semivolatile constituent for which no matrix spike was performed. For example, no matrix spike was performed for di-n-butyl phthalate, a base/neutral fraction semivolatile, in rotary kiln incinerator ash; however, the treatment performance data for this constituent were adjusted for accuracy using a matrix spike recovery of 103 percent. This recovery was developed by averaging the matrix spike recoveries calculated for all base/neutral fraction semivolatiles in the first matrix spike (104%) and the duplicate spike (103%). The lower average matrix spike recovery of 103% was selected to subsequently calculate the accuracy correction factor and the corrected treatment concentration for di-n-butyl phthalate.

The accuracy correction factors for rotary kiln ash data are presented in Table D-6 of Appendix D of this document. The corrected treatment concentrations for the BDAT List organic constituents detected in either the untreated K019 or rotary kiln ash are presented in Table 5-1 for kiln ash residue. Note that constituent concentrations were not adjusted to values below the detection limit for each constituent. If accuracy correction resulted in a value less than the detection limit, the accuracy-corrected concentration was set equal to the detection limit.

5.2.2 Wastewater

Matrix spike recoveries used to calculate accuracy correction factors for adjustment of the treatment performance data are presented in Table D-5 of Appendix D. As shown in Table D-5, if duplicate matrix spikes were performed for an organic constituent, the matrix spike recovery used for that constituent was the lower of the two values from the first matrix spike and the duplicate spike.

Where a matrix spike was not performed for an organic constituent, the matrix spike recovery for that constituent was derived from the average matrix spike recoveries of the appropriate group of constituents (volatile or semivolatile constituents) for which recovery data were available. In these cases, the matrix spike recoveries for all volatiles or semivolatiles from the first matrix spike were averaged. Similarly, an average matrix spike recovery was calculated for the duplicate matrix spike recoveries. The lower of the two average matrix spike recoveries of the volatile or semivolatile group was used for any volatile or semivolatile constituent for which no matrix spike was performed. For example, no matrix spike was performed for 1,1,2-trichloroethane, a volatile, in scrubber water; however, the treatment performance data for this constituent were adjusted for accuracy using a matrix spike recovery of 78 percent. This recovery was determined by averaging the matrix spike recoveries calculated for all volatiles in the first matrix spike

(83%) and the duplicate spike (78%). The lower average matrix spike recovery of 78% was selected to subsequently calculate the accuracy correction factor and the corrected treatment concentration for 1,1,2-trichloroethane.

The accuracy correction factors for wastewater (scrubber water) data calculated using this method are presented in Table D-6 of Appendix D of this document. The corrected treatment concentrations for each BDAT List organic constituent detected in either the untreated K019 or scrubber water are presented in Table 5-2. Scrubber water concentrations were not adjusted to values below the detection limit for each constituent. If accuracy correction resulted in a value less than the detection limit, the accuracy-corrected value was set equal to the detection limit.

5.3 Statistical Comparison of Performance Data

In cases where the Agency has treatment data from more than one technology, EPA uses the statistical method known as the analysis of variance, ANOVA (discussed in Section 1.0), to determine if one technology performs significantly better than the rest. In this case the Agency has treatment data only for rotary kiln incineration of K019 at plant A; therefore, an ANOVA comparison is not applicable and rotary kiln incineration is determined to be BDAT for the nonwastewater forms of K019.

5.4 BDAT for K016, K018, K019, K020 and K030

The best demonstrated and available technology for K019 has been determined to be rotary kiln incineration. As discussed in Section 2.0, EPA has determined that the chlorinated organics waste group, K016, K018, K019, K020 and K030, represents a single waste treatability group. Therefore, since rotary kiln incineration has been determined to be BDAT for K019, this technology is also BDAT for K016, K018, K020 and K030.

Table 5-1

TREATMENT CONCENTRATIONS FOR K019 KILN ASH RESIDUE CORRECTED FOR ACCURACY*

		Sample Set					
	Constituent	1 (ppm)	2 (ppm)	3 (ppm)	4 (ppm)	5 (ppm)	6 (ppm)
7.	Carbon tetrachloride	2.13	2.13	2.13	2.13	2.13	2.13
9.	Chlorobenzene	2.02	2.02	2.02	2.02	2.02	2.02
14.	Chloroform	2.13	2.13	2.13	2.13	2.13	2.13
22.	1,1-Dichloroethane	2.13	2.13	2.13	2.13	2.13	2.13
23.	1,2-Dichloroethane	2.13	2.13	2.13	2.13	2.13	2.13
42.	Tetrachloroethene	2.13	2.13	2.13	2.13	2.13	2.13
45.	1,1,1-Trichloroethane	2.13	2.13	2.13	2.13	2.13	2.13
47.	Trichloroethene	2.00	2.00	2.00	2.00	2.00	2.00
68.	Bis(2-chloroethyl)ether	2.00	2.00	2.00	2.00	2.00	2.00
70.	Bis(2-ethylhexyl)phthalate	2.00	2.00	2.00	11.7	2.00	2.00
98.	Di-n-butyl phthalate	2.00	2.00	2.00	223	2.00	2.00
109.	Fluorene	2.00	2.00	2.00	2.00	2.00	2.00
110.	Hexachlorobenzene	10	10	10	10	10	10
113.	Hexachloroethane	10	10	10	10	10	10
121.	Naphthalene	2.00	2.00	2.00	2.00	2.00	2.00
136.	Pentachlorobenzene	10	10	10	10	10	10
141.	Phenanthrene	2.00	2.00	2.00	2.00	2.00	2.00
148.	1,2,4,5-Tetrachlorobenzene	5.00	5.00	5.00	5.00	5.00	5.00
150.	1,2,4-Trichlorobenzene	6.67	6.67	6.67	6.67	6.67	6.67

*This table presents corrected treatment concentrations for the BDAT List organic constituents detected in either the untreated K019 or rotary kiln ash from plant A. Calculations are shown in Appendix D.

Table 5-2

TREATMENT CONCENTRATIONS FOR SCRUBBER WATER CORRECTED FOR ACCURACY*

		Sample Set					
	Constituent	1 (ppm)	2 (ppm)	3 (ppm)	4 (ppm)	5 (ppm)	6 (ppm)
7.	Carbon tetrachloride	0.003	0.003	0.003	0.003	0.003	0.003
9.	Chlorobenzene	0.002	0.002	0.002	0.002	0.002	0.002
14.	Chloroform	0.005	0.005	0.005	0.005	0.005	0.005
21.	Dichlorodifluoromethane	0.003	0.003	0.006	0.018	0.003	0.003
22.	1,1-Dichloroethane	0.003	0.003	0.003	0.003	0.003	0.003
23.	1,2-Dichloroethane	0.003	0.003	0.003	0.003	0.003	0.003
42.	Tetrachloroethene	0.003	0.003	0.003	0.003	0.003	0.003
43.	Toluene	0.003	0.004	0.003	0.003	0.003	0.003
45.	1,1,1-Trichloroethane	0.003	0.004	0.003	0.003	0.003	0.003
47.	Trichloroethene	0.002	0.002	0.002	0.002	0.002	0.002
68.	Bis(2-chloroethyl)ether	0.002	0.002	0.002	0.002	0.002	0.002
88.	p-Dichlorobenzene	0.003	0.003	0.003	0.003	0.003	0.003
98.	Di-n-butyl phthalate	0.002	0.008	0.005	0.005	0.003	0.003
109.	Fluorene	0.002	0.002	0.002	0.002	0.002	0.002
110.	Hexachlorobenzene	0.012	0.012	0.012	0.012	0.012	0.012
113.	Hexachloroethane	0.012	0.012	0.012	0.012	0.012	0.012
121.	Naphthalene	0.002	0.002	0.002	0.002	0.002	0.002
136.	Pentachlorobenzene	0.012	0.012	0.012	0.012	0.012	0.012
141.	Phenanthrene	0.002	0.002	0.002	0.002	0.002	0.002
148.	1,2,4,5-Tetrachlorobenzene	0.006	0.006	0.006	0.006	0.006	0.006
150.	1,2,4-Trichlorobenzene	0.008	0.008	0.008	0.008	0.008	0.008

*This table presents corrected treatment concentrations for the BDAT List organic constituents detected in either the untreated K019 or scrubber water from plant A. Calculations are shown in Appendix D.

6.0 SELECTION OF REGULATED CONSTITUENTS

This section presents the methodology and rationale for selection of the regulated constituents in wastewater and nonwastewater forms of K016, K018, K019, K020, and K030.

The Agency initially considered for regulation all constituents on the BDAT List (see Table 1-1, Section 1.0). Summarized in Table 6-1 for each wastecode are available waste characterization data for the BDAT List constituents. For constituents known to be present in the wastes, the range of detected concentration is shown in the table. Those constituents that were analyzed but were not detected in the wastes are identified by "ND". Constituents for which the Agency does not have analytical characterization data are identified by "NA" (not analyzed). As explained in Section 1.0, the Agency is not regulating all of the constituents considered for regulation in order to reduce the analytical cost burdens on the treater and to facilitate implementation of the compliance and enforcement program. As discussed further below, a BDAT List constituent was not considered for regulation if: (1) the constituent was not detected in the untreated waste; (2) the constituent was not analyzed in the untreated waste; or (3) detection limits or analytical results were not obtained for the constituent due to analytical or accuracy problems. Some additional constituents were deleted from consideration for regulation, as discussed in Section 6.1.

BDAT List Constituents That Were Not Detected in the Untreated Waste. In general, constituents that were not detected in the untreated waste (labelled ND in Table 6-1) were not considered for regulation. One exception is for constituents that were detected in the treated waste (labelled ND* in Table 6-1). These constituents may have been present but were not detected in the untreated wastes due to analytical masking problems or that they may not have been present in the untreated waste, but were formed during the incineration process. The constituents are: bis(2-ethylhexyl)phthalate and di-n-butyl phthalate which were not detected in untreated K019 but were detected in kiln ash residue from rotary kiln incineration of K019 at plant A (sampled by EPA); toluene and di-n-butyl phthalate which were also not detected in untreated K019 but were detected in the scrubber water residual from rotary kiln incineration of K019.

Dichlorodifluoromethane was not detected in the untreated K019 but was detected in the scrubber water residual at plant A. This constituent is believed to be present in the waste due to the contamination from a process coolant system at plant A. The detection limits determined in the characterization of K019 are presented in Appendix F.

BDAT List Constituents That Were Not Analyzed. Some constituents on the BDAT List were not considered for regulation because they were not analyzed in the untreated wastes (labelled NA, in Table 6-1). Some constituents were not analyzed in the untreated wastes based on the judgment that it is extremely unlikely that the constituent would be present in the wastes. Other constituents were not analyzed in the untreated waste because they were not on the BDAT List of constituents at the time of analysis. In cases where data were submitted to the Agency by outside sources, it may not be known if and/or why constituents were not analyzed.

Constituents For Which Analytical Results Were Not Obtained Due to Analytical or Accuracy Problems. Some constituents on the BDAT List were not considered for regulation because detection limits or analytical results were not obtained due to analytical or accuracy problems (labelled A in Table 6-1). The analytical and accuracy problems include: (1) laboratory QA/QC analyses indicated inadequate recoveries and, therefore, the accuracy of the analysis for the constituent could not be ensured; (2) a standard was not available for the constituent and, therefore, system calibration could not be performed for the constituent; and (3) colorimetric interferences occurred during analysis for the constituent and, therefore, accurate analyses could not be performed.

6.1 BDAT List Constituents Detected in Untreated Waste But Not Considered for Regulation

Some BDAT List constituents that were detected in the untreated K016, K018, K019, K020, and K030 wastes were not considered for regulation if (1) available treatment performance data for the constituent did not show effective treatment by BDAT; (2) treatment performance data were not available for the constituent; or (3) the constituent was not present at treatable concentrations in the waste; or (4) other reasons as described below. BDAT

List constituents that were further considered for regulation following the deletions described in this section are listed in Table 6-2.

BDAT List metal constituents were not considered for regulation in K016, K018, K019, K020, and K030 because these constituents were not detected at treatable concentrations in either the untreated K019 waste or the K019 treatment residuals (incinerator ash and scrubber water). Data were not available for metals analyses in K016, K018, K020, and K030. However, due to the similarity between these wastes and K019, metals would also not be expected to be present at treatable concentrations in K016, K018, K020, and K030. Furthermore, incineration, the technology for which treatment performance data were collected for K019 waste, does not provide substantial treatment for metals.

Sulfide was not considered for regulation for K019 nonwastewater because the technology determined to be BDAT for K019 (rotary kiln incineration) does not provide effective treatment for this constituent. Moreover, the Agency is unaware of any demonstrated technology for treatment of sulfide in K019.

6.2 Constituents Selected for Regulation

BDAT List constituents selected for regulation in K016, K018, K019, K020, and K030 are presented in Table 6-3. The selection of regulated constituents in nonwastewaters is discussed in Section 6.2.1 and for wastewaters in Section 6.2.2.

6.2.1 Selection of Regulated Constituents in Nonwastewater

Regulated organic and inorganic constituents in nonwastewater were selected from those BDAT List organic and inorganic constituents detected in the untreated wastes that were effectively treated by rotary kiln incineration and from those constituents that were detected in the treated wastes.

As explained in Section 1.0, the Agency is not regulating all of the constituents considered for regulation (Table 6-2) to reduce the analytical cost burdens on the treater and to facilitate implementation of the compliance and enforcement program. Included in Table 6-3 are constituents selected for regulation after consideration of: (1) constituent concentration levels in the untreated waste; (2) whether the constituents are adequately controlled by the regulation of another constituent; (3) the relative difficulty associated with achieving effective treatment of the constituent by BDAT.

Determination of adequate control for organic constituents was based on an evaluation of the characteristics of the constituents that would affect performance of rotary kiln incineration relative to the kiln ash residual, specifically, the boiling point of the constituents. In general, a constituent is believed to be controlled by regulation of another constituent that has a higher boiling point. Boiling points for all BDAT List constituents considered for regulation are tabulated in Appendix E.

The constituents selected for regulation and the constituents controlled by regulating other constituents are discussed below for each waste code.

K016

All constituents considered for regulation in K016 nonwastewater were selected for regulation. The constituents selected for regulation are tetrachloroethene, hexachlorobenzene, hexachlorobutadiene, hexachlorocyclopentadiene, and hexachloroethane.

K018

Chloroethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,1,1-trichloroethane, hexachlorobenzene, hexachlorobutadiene, hexachloroethane, and pentachloroethane were selected for regulation in K018 nonwastewater. Chloromethane and 1,1,2-trichloroethane were detected in untreated K018 and were considered for regulation, but were not selected because they were found at lower concentrations in the untreated waste and they are believed to be adequately controlled by incineration of other constituents that have been selected for regulation. This decision was based on a comparison of boiling points of those constituents considered for regulation. EPA believes that chloromethane (bp -24°C) will be adequately controlled by regulation of chloroethane (bp 12°C), 1,1-dichloroethane (bp 57°C), and other regulated constituents with boiling points higher than -24°C. 1,1,2-Trichloroethane (bp 113°C) will be adequately controlled by regulation of pentachloroethane (bp 161°C), hexachloroethane (bp 187°C), and other regulated constituents with boiling points higher than 113°C.

K019

Chlorobenzene, chloroform, 1,2-dichloroethane, tetrachloroethene, 1,1,1-trichloroethane, bis(2-chloroethyl)ether, hexachloroethane, naphthalene, phenanthrene, and 1,2,4-trichlorobenzene were selected for regulation in K019 nonwastewater. Carbon tetrachloride, 1,1-dichloroethane, 1,1,2,2-tetrachloroethane, trichloroethene, 1,1,2-trichloroethane, p-dichlorobenzene, fluorene, hexachlorobutadiene, hexachlorobenzene, pentachlorobenzene, and 1,2,4,5-tetrachlorobenzene were detected in untreated K019 and were considered for regulation, but were not selected because these constituents were found at lower concentrations in the untreated waste and they are believed to be adequately controlled by incineration of other constituents which have been selected for regulation. This decision was based on a comparison of the boiling points of those constituents considered for regulation. EPA believes that carbon tetrachloride (bp 77°C) will be adequately controlled by regulation of chlorobenzene (bp 131°C), 1,2-dichloroethane (bp 83°C), and other regulated constituents with boiling points higher than 77°C. 1,1-Dichloroethane (bp 57°C) will be adequately controlled by regulation of chlorobenzene (bp 131°C), chloroform (bp 61°C), and other regulated constituents with boiling points higher than 57°C. Trichloroethene (bp 87°) will be adequately controlled by regulation of chlorobenzene (bp 131°C), tetrachloroethene (bp 121°C), and other regulated constituents with boiling points higher than 87°C. p-Dichlorobenzene (bp 174°C) will be adequately controlled by regulation of bis(2-chloroethyl)ether (bp 178°C), hexachloroethane (bp 187°C), and other regulated constituents with boiling points higher than 174°C. 1,1,2-Trichloroethane (bp 113°C) and 1,1,2,2-tetrachloroethane (bp 147°C) will be adequately controlled by regulation of bis(2-chloroethyl)ether (bp 178°C), and other regulated constituents with boiling points higher than 147°C. Fluorene (bp 295°C), hexachlorobutadiene (bp 215°C), hexachlorobenzene (bp 324°C), pentachlorobenzene (bp 276°C), and 1,2,4,5-trichlorobenzene (bp 246°C) will be adequately controlled by regulation of phenanthrene (bp 340°C).

Bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were not detected in untreated K019 but were detected in kiln ash residue from rotary kiln incineration of K019 at plant A (sampled by EPA). These constituents were considered for regulation but were not selected because they were found at treatable concentrations in another waste (RCRA Blend) that was incinerated with K019 during the sampling episode at plant A.

K020

1,2-Dichloroethane, 1,1,2,2-tetrachloroethane, and tetrachloroethene, were selected for regulation in K020 nonwastewater. 1,1,2-Trichloroethane was considered for regulation, but was not selected because it was found at a lower concentration in the untreated waste, and it is believed to be adequately controlled by incineration of other constituents which have been selected for regulation. This decision was based on a comparison of the boiling points of those constituents considered for regulation. EPA believes that 1,1,2-trichloroethane (bp 113°C) will be adequately controlled by regulation of 1,1,2,2-tetrachloroethane (bp 147°C) and tetrachloroethene (bp 121°C).

K030

Tetrachloroethene, hexachlorobutadiene, hexachloroethane, hexachloropropene, pentachlorobenzene, pentachloroethane, 1,2,4,5-tetrachlorobenzene, and 1,2,4-trichlorobenzene were selected for regulation in K030 nonwastewater. o-Dichlorobenzene, p-dichlorobenzene, and hexachlorocyclopentadiene were detected in untreated K030 and were considered for regulation but were not selected because these constituents were found at lower concentrations in the untreated waste and they are believed to be adequately controlled by incineration of other constituents which have been selected for regulation. This decision was based on a comparison of the boiling points of those constituents considered for regulation. EPA believes that o-dichlorobenzene (bp 181°) and p-dichlorobenzene (bp 174°C) will be adequately controlled by regulation of hexachlorobutadiene (bp 215°C), hexachloroethane (bp 187°C), and other regulated constituents with boiling points higher than 181°C. Hexachlorocyclopentadiene (bp 234°C) will be adequately controlled by regulation of pentachlorobenzene (bp 276°C) and 1,2,4,5-tetrachlorobenzene (bp 246°C).

6.3.2 Selection of Regulated Constituents in Wastewaters

Regulated constituents for wastewater forms of K016, K018, K019, K020, and K030 were selected based on the method used for nonwastewaters; that is, regulated organic and inorganic constituents in wastewater were selected from the BDAT List organic constituents detected in the untreated wastes that showed effective treatment using rotary kiln incineration and from those constituents that were detected in the treated wastes.

As explained in Section 1.0, not all of the constituents considered for regulation (Table 6-2) will be regulated by the Agency to reduce the analytical cost burdens on the treater and to facilitate implementation of the compliance and enforcement program. Table 6-3 presents the constituents selected for regulation after consideration of: (1) constituent concentration in the untreated waste; (2) whether the constituents are adequately controlled by the regulation of another constituent; (3) the relative difficulty associated with achieving effective treatment of the constituent by BDAT.

The Agency's determination of adequate control for organic constituents is based on an evaluation of the characteristics of the constituents that would affect performance of incineration relative to the scrubber water residual, specifically, the estimated bond dissociation energies for the constituents. In general, a constituent is believed to be controlled by regulation of another constituent that has a higher bond dissociation energy. Estimated bond dissociation energies for all BDAT list constituents considered for regulation are tabulated in Appendix E.

The constituents selected for regulation and the constituents controlled by regulating other constituents are discussed below by waste code.

K016

All constituents considered for regulation in K016 wastewater were selected for regulation. The constituents selected for regulation are tetrachloroethene, hexachlorobenzene, hexachlorobutadiene, hexachlorocyclopentadiene, and hexachloroethane.

K018

Chloroethane, chloromethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,1,1-trichloroethane, hexachlorobenzene, hexachlorobutadiene, and pentachloroethane were selected for regulation in K018 wastewater. Hexachloroethane and 1,1,2-trichloroethane were considered for regulation but were not selected because these constituents were found in lower concentrations in the untreated waste, and they are believed to be adequately controlled by incineration of other constituents which have been selected for regulation. This decision was based on a comparison of bond dissociation energies (BDE) of those constituents considered for regulation. EPA believes that hexachloroethane (BDE 655 kcal/mole) will be adequately controlled by regulation of pentachloroethane (BDE 660 kcal/mole), 1,1,1-trichloroethane (BDE 670 kcal/mole), and other regulated constituents with bond dissociation energies greater than 655 kcal/mole. 1,1,2-Trichloroethane (BDE 670 kcal/mole), will be adequately controlled by regulation of 1,1-dichloroethane (BDE 675 kcal/mole), 1,2-dichloroethane (BDE 675 kcal/mole), and other regulated constituents with bond dissociation energies higher than 670 kcal/mole.

K019

Chlorobenzene, chloroform, 1,2-dichloroethane, tetrachloroethene, 1,1,1-trichloroethane, bis(2-chloroethyl)ether, p-dichlorobenzene, fluorene, hexachloroethane, naphthalene, phenanthrene, 1,2,4,5-tetrachlorobenzene, and 1,2,4-trichlorobenzene were selected for regulation in K019 wastewater. Carbon tetrachloride, 1,1-dichloroethane, trichloroethene, hexachlorobutadiene, hexachlorobenzene, and pentachlorobenzene were considered for regulation but were not selected because these constituents were found in lower concentrations in the untreated waste, and they are believed to be adequately controlled by incineration of other constituents which have been selected for regulation. 1,1,2-Trichloroethane and 1,1,2,2-tetrachloroethane were considered for regulation but were not selected for regulation because these constituents are believed to be adequately controlled by incineration of other constituents which have been selected for regulation. This decision was based on a comparison of bond dissociation energies (BDE) of those constituents considered for regulation. EPA believes that carbon tetrachloride (BDE 380 kcal/mole), 1,1-dichloroethane (BDE 675 kcal/mole), trichloroethene (BDE 481 kcal/mole), 1,1,2-trichloroethane (BDE 670 kcal/mole), and 1,1,2,2-tetrachloroethane (BDE 665 kcal/mole) will be adequately controlled by regulation of bis(2-chloroethyl)ether (BDE 1290 kcal/mole), chlorobenzene (BDE 1320 kcal/mole), and other regulated constituents with bond dissociation energies greater than 670 kcal/mole. Hexachlorobutadiene (BDE 855 kcal/mole), hexachlorobenzene (BDE 1310 kcal/mole), and pentachlorobenzene (BDE 1320 kcal/mole) will be adequately controlled by regulation of chlorobenzene (BDE 1320 kcal/mole), p-dichlorobenzene (BDE 1330 kcal/mole), and other regulated constituents with bond dissociation energies greater than 1320 kcal/mole.

Dichlorodifluoromethane, toluene, and di-n-butyl phthalate were not detected in untreated K019 waste but were detected in the scrubber water residual from rotary kiln incineration of K019 at plant A (sampled by EPA). These constituents were considered but not selected for regulation in K019 wastewater. Toluene and di-n-butyl phthalate were not selected for regulation because they were present at treatable concentrations in other wastes that were incinerated with K019 during the sampling episode at plant A. Dichlorodifluoromethane may have been a contaminant from the process coolant system at plant A since it was not detected in any of the wastes incinerated at plant A during the sampling episode. EPA does not believe that this constituent was formed as a result of incineration of K019, since there is neither fluoride nor a source of fluorine in K019. Therefore, dichlorodifluoromethane was not selected for regulation.

K020

1,2-Dichloroethane, 1,1,2,2-tetrachloroethane, and tetrachloroethene were selected for regulation in K020 wastewater. 1,1,2-trichloroethane was considered for regulation but was not selected for regulation because it was found at a lower concentration in the untreated waste, and it was believed to be adequately controlled by incineration of other regulated constituents which have been selected for regulation. This decision was based on a comparison of bond dissociation energies (BDE) of those constituents considered for regulation. EPA believes that 1,1,2-trichloroethane (BDE 670 kcal/mole) will be adequately controlled by regulation of 1,2-dichloroethane (BDE 675 kcal/mole).

K030

Tetrachloroethene, o-dichlorobenzene, p-dichlorobenzene, hexachlorobutadiene, hexachloroethane, pentachloroethane, 1,2,4,5-tetrachlorobenzene, and 1,2,4-trichlorobenzene were selected for regulation in K030 wastewater. Hexachlorocyclopentadiene, hexachloropropene, and pentachlorobenzene were considered for regulation but were not selected for regulation because these constituents were found at lower concentration in the untreated waste, and they are believed to be adequately controlled by incineration of other constituents which have been selected for regulation. This decision was based on a comparison of bond dissociation energies (BDE) of those constituents considered for regulation. EPA believes that hexachlorocyclopentadiene (BDE 1020 kcal/mole), hexachloropropene (BDE 710 kcal/mole), and pentachlorobenzene (BDE 1320 kcal/mole) will be adequately controlled by regulation of o-dichlorobenzene (BDE 1330 kcal/mole), p-dichlorobenzene (BDE 1330 kcal/mole), 1,2,4,5-tetrachlorobenzene (BDE 1320 kcal/mole), and 1,2,4-trichlorobenzene (BDE 1325 kcal/mole).

Table 6-1

STATUS OF BDAT LIST CONSTITUENTS PRESENT IN UNTREATED K016, K018-K020, K030 WASTES

		K016 Detection Status (mg/kg)	K018 Detection Status (mg/kg)	K019 Detection Status (mg/kg)	K020 Detection Status (mg/kg)	K030 Detection Status (mg/kg)
Volatiles						
222.	Acetone	ND	ND	NA	ND	ND
1.	Acetonitrile	NA	NA	ND	NA	NA
2.	Acrolein	NA	NA	ND	NA	NA
3.	Acrylonitrile	NA	NA	ND	NA	NA
4.	Benzene	ND	ND	ND	ND	ND
5.	Bromodichloromethane	ND	ND	ND	ND	ND
6.	Bromomethane	ND	ND	ND	ND	ND
223.	n-Butyl alcohol	NA	NA	NA	NA	NA
7.	Carbon tetrachloride	ND	ND	3,500-<25,000	ND	ND
8.	Carbon disulfide	NA	NA	ND	NA	NA
9.	Chlorobenzene	ND	ND	<2,000-<25,000	ND	ND
10.	2-Chloro-1,3-butadiene	NA	NA	ND	NA	NA
11.	Chlorodibromomethane	ND	ND	ND	ND	ND
12.	Chloroethane	ND	64,000-180,000	ND	ND	ND
13.	2-Chloroethyl vinyl ether	ND	ND	ND	ND	ND
14.	Chloroform	ND	ND	4,600-<25,000	ND	ND
15.	Chloromethane	ND	6,500-<10,000	ND	ND	ND
16.	3-Chloropropene	NA	NA	ND	NA	NA
17.	1,2-Dibromo-3-chloropropane	NA	NA	ND	NA	NA
18.	1,2-Dibromoethane	NA	NA	ND	NA	NA
19.	Dibromomethane	NA	NA	ND	NA	NA
20.	trans-1,4-Dichloro-2-butene	ND	ND	ND	ND	ND
21.	Dichlorodifluoromethane	NA	ND	ND*	ND	ND
22.	1,1-Dichloroethane	ND	3,500-710,000	<2,000-<25,000	ND	ND
23.	1,2-Dichloroethane	ND	<5,000-96,000	87,000-500,000	D	ND
24.	1,1-Dichloroethylene	ND	ND	ND	ND	ND
25.	trans-1,2-Dichloroethene	ND	ND	ND	ND	ND
26.	1,2-Dichloropropane	ND	ND	ND	ND	ND
27.	trans-1,3-Dichloropropene	ND	ND	ND	ND	ND
28.	cis-1,3-Dichloropropene	ND	ND	ND	ND	ND
29.	1,4-Dioxane	NA	NA	ND	NA	NA
224.	2-Ethoxyethanol	NA	NA	NA	NA	NA
225.	Ethyl acetate	NA	NA	NA	NA	NA
226.	Ethyl benzene	ND	ND	ND	ND	ND
30.	Ethyl cyanide	NA	NA	NA	NA	NA
227.	Ethyl ether	NA	NA	ND	NA	NA
31.	Ethyl methacrylate	NA	NA	NA	NA	NA
214.	Ethylene oxide	NA	NA	NA	NA	NA

NA - Not analyzed.
ND - Not detected.
ND* - This constituent was not detected in untreated waste but was detected in the treated residual.
D - This constituent was detected in the untreated waste. The concentration range detected is available in the confidential portion of the Administrative Record for this rulemaking.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS PRESENT IN UNTREATED K016, K018-K020, K030 WASTES

	K016 Detection Status (mg/kg)	K018 Detection Status (mg/kg)	K019 Detection Status (mg/kg)	K020 Detection Status (mg/kg)	K030 Detection Status (mg/kg)
Volatiles (Cont.)					
32. Iodomethane	NA	NA	ND	NA	NA
33. Isobutyl alcohol	NA	NA	ND	NA	NA
228. Methanol	NA	NA	NA	NA	NA
34. Methyl ethyl ketone	NA	NA	ND	NA	NA
229. Methyl isobutyl ketone	NA	NA	NA	NA	NA
35. Methyl methacrylate	NA	NA	ND	NA	NA
37. Methacrylonitrile	NA	NA	ND	NA	NA
38. Methylene chloride	ND	ND	ND	ND	ND
230. 2-Nitropropane	NA	NA	NA	NA	NA
39. Pyridine	NA	NA	ND	NA	NA
40. 1,1,1,2-Tetrachloroethane	ND	ND	ND	ND	ND
41. 1,1,2,2-Tetrachloroethane	ND	ND	<2,000-130,000	D	ND
42. Tetrachloroethene	20,000-150,000	ND	6,000-<25,000	D	D
43. Toluene	ND	ND	ND*	ND	ND
44. Tribromomethane	NA	NA	ND	NA	NA
45. 1,1,1-Trichloroethane	ND	<250-6,400	<25,000-81,000	ND	ND
46. 1,1,2-Trichloroethane	ND	<250-23,000	<2,000-28,000	D	ND
47. Trichloroethene	ND	ND	2,200-<25,000	ND	ND
48. Trichloromonofluoromethane	NA	NA	ND	NA	NA
49. 1,2,3-Trichloropropane	ND	ND	ND	ND	ND
231. 1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA	NA	NA
50. Vinyl chloride	ND	ND	ND	ND	ND
215. 1,2-Xylene	ND	ND	ND	ND	ND
216. 1,3-Xylene	ND	ND	ND	ND	ND
217. 1,4-Xylene	ND	ND	ND	ND	ND
Semivolatiles					
51. Acenaphthalene	NA	NA	ND	NA	NA
52. Acenaphthene	NA	NA	ND	NA	NA
53. Acetophenone	NA	NA	ND	NA	NA
54. 2-Acetylaminofluorene	NA	NA	ND	NA	NA
55. 4-Aminobiphenyl	NA	NA	ND	NA	NA
56. Aniline	NA	NA	ND	NA	NA
57. Anthracene	NA	NA	ND	NA	NA
58. Aramite	NA	NA	ND	NA	NA
59. Benz(a)anthracene	NA	NA	ND	NA	NA
218. Benzal chloride	NA	NA	NA	NA	NA
60. Benzenethiol	NA	NA	ND	NA	NA

NA - Not analyzed.
ND - Not detected.
ND* - This constituent was not detected in untreated waste but was detected in the treated residual.
D - This constituent was detected in the untreated waste. The concentration range detected is available in the confidential portion of the Administrative Record for this rulemaking.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS PRESENT IN UNTREATED K016, K018-K020, K030 WASTES

		K016 Detection Status (mg/kg)	K018 Detection Status (mg/kg)	K019 Detection Status (mg/kg)	K020 Detection Status (mg/kg)	K030 Detection Status (mg/kg)
Semivolatiles (Cont.)						
62.	Benzo(a)pyrene	NA	NA	ND	NA	NA
63.	Benzo(b)fluoranthene	NA	NA	ND	NA	NA
64.	Benzo(ghi)perylene	NA	NA	ND	NA	NA
65.	Benzo(k)fluoranthene	NA	NA	ND	NA	NA
66.	p-Benzoquinone	NA	NA	ND	NA	NA
67.	Bis(2-chloroethoxy)ethane	ND	ND	ND	ND	ND
68.	Bis(2-chloroethyl)ether	ND	ND	<20-340	ND	ND
69.	Bis(2-chloroisopropyl)ether	ND	ND	ND	ND	ND
70.	Bis(2-ethylhexyl)phthalate	NA	NA	ND*	NA	NA
71.	4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND
72.	Butyl benzyl phthalate	NA	NA	ND	NA	NA
73.	2-sec-Butyl-4,6-dinitrophenol	NA	NA	ND	NA	NA
74.	p-Chloroaniline	NA	NA	ND	NA	NA
75.	Chlorobenzilate	NA	NA	ND	NA	NA
76.	p-Chloro-m-cresol	NA	NA	ND	NA	NA
77.	2-Chloronaphthalene	ND	ND	ND	ND	ND
78.	2-Chlorophenol	ND	ND	ND	ND	ND
79.	3-Chloropropionitrile	NA	NA	ND	NA	NA
80.	Chrysene	NA	NA	ND	NA	NA
81.	ortho-Cresol	NA	NA	ND	NA	NA
82.	para-Cresol	NA	NA	ND	NA	NA
232.	Cyclohexanone	NA	NA	NA	NA	NA
83.	Dibenz(a,h)anthracene	NA	NA	ND	NA	NA
84.	Dibenzo(a,e)pyrene	NA	NA	ND	NA	NA
85.	Dibenzo(a,i)pyrene	NA	NA	ND	NA	NA
86.	m-Dichlorobenzene	ND	ND	ND	ND	D
87.	o-Dichlorobenzene	ND	ND	ND	ND	D
88.	p-Dichlorobenzene	ND	ND	<20-90	NA	NA
89.	3,3'-Dichlorobenzidine	NA	NA	ND	ND	ND
90.	2,4-Dichlorophenol	ND	ND	ND	ND	ND
91.	2,6-Dichlorophenol	ND	ND	ND	NA	NA
92.	Diethyl phthalate	NA	NA	ND	NA	NA
93.	3,3'-Dimethoxybenzidine	NA	NA	ND	NA	NA
94.	p-Dimethylaminoazobenzene	NA	NA	ND	NA	NA
95.	3,3'-Dimethylbenzidine	NA	NA	ND	NA	NA
96.	2,4-Dimethylphenol	NA	NA	ND	NA	NA
97.	Dimethyl phthalate	NA	NA	ND	NA	NA

NA - Not analyzed.
ND - Not detected.
ND* - This constituent was not detected in untreated waste but was detected in the treated residual.
D - This constituent was detected in the untreated waste. The concentration range detected is available in the confidential portion of the Administrative Record for this rulemaking.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS PRESENT IN UNTREATED K016, K018-K020, K030 WASTES

	K016 Detection Status (mg/kg)	K018 Detection Status (mg/kg)	K019 Detection Status (mg/kg)	K020 Detection Status (mg/kg)	K030 Detection Status (mg/kg)
Semivolatiles (Cont.)					
98. Di-n-butyl phthalate	NA	NA	ND*	NA	NA
99. 1,4-Dinitrobenzene	NA	NA	ND	NA	NA
100. 4,6-Dinitro-o-cresol	NA	NA	ND	NA	NA
101. 2,4-Dinitrophenol	NA	NA	ND	NA	NA
102. 2,4-Dinitrotoluene	NA	NA	ND	NA	NA
103. 2,6-Dinitrotoluene	NA	NA	ND	NA	NA
104. Di-n-octyl phthalate	NA	NA	ND	NA	NA
105. Di-n-propylnitrosamine	NA	NA	ND	NA	NA
106. Diphenylamine	NA	NA	ND	NA	NA
219. Diphenylnitrosamine	NA	NA	NA	NA	NA
107. 1,2-Diphenylhydrazine	NA	NA	ND	NA	NA
108. Fluoranthene	NA	NA	ND	NA	NA
109. Fluorene	NA	NA	16-22	NA	NA
110. Hexachlorobenzene	<99-54,000	29-<740	<20-87	ND	ND
111. Hexachlorobutadiene	34,000-81,000	31-<740	<20-94	ND	D
112. Hexachlorocyclopentadiene	5,900-7,100	ND	ND	ND	D
113. Hexachloroethane	25,000-38,000	22-<740	<20-120	ND	D
114. Hexachlorophene	NA	NA	ND	NA	NA
115. Hexachloropropene	ND	ND	ND	ND	D
116. Indeno(1,2,3-cd)pyrene	NA	NA	ND	NA	NA
117. Isosafrole	NA	NA	ND	NA	NA
118. Methapyrilene	NA	NA	ND	NA	NA
119. 3-Methylcholanthrene	NA	NA	ND	NA	NA
120. 4,4'-Methylenebis (2-chloroaniline)	NA	NA	ND	NA	NA
36. Methyl methanesulfonate	NA	NA	ND	NA	NA
121. Naphthalene	NA	NA	314-470	NA	NA
122. 1,4-Naphthoquinone	NA	NA	ND	NA	NA
123. 1-Naphthylamine	NA	NA	ND	NA	NA
124. 2-Naphthylamine	NA	NA	ND	NA	NA
125. p-Nitroaniline	NA	NA	ND	NA	NA
126. Nitrobenzene	NA	NA	ND	NA	NA
127. 4-Nitrophenol	NA	NA	ND	NA	NA
128. N-Nitrosodi-n-butylamine	NA	NA	ND	NA	NA
129. N-Nitrosodiethylamine	NA	NA	ND	NA	NA
130. N-Nitrosodimethylamine	NA	NA	ND	NA	NA
131. N-Nitrosomethylethylamine	NA	NA	ND	NA	NA
132. N-Nitrosomorpholine	NA	NA	ND	NA	NA

NA - Not analyzed.
ND - Not detected.
ND* - This constituent was not detected in untreated waste but was detected in the treated residual.
D - This constituent was detected in the untreated waste. The concentration range detected is available in the confidential portion of the Administrative Record for this rulemaking.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS PRESENT IN UNTREATED K016, K018-K020, K030 WASTES

	K016 Detection Status (mg/kg)	K018 Detection Status (mg/kg)	K019 Detection Status (mg/kg)	K020 Detection Status (mg/kg)	K030 Detection Status (mg/kg)
Semivolatiles (Cont.)					
133. N-Nitrosopiperidine	NA	NA	ND	NA	NA
134. N-Nitrosopyrrolidine	NA	NA	ND	NA	NA
135. 5-Nitro-o-toluidine	NA	NA	ND	NA	NA
136. Pentachlorobenzene	ND	ND	<20-65	ND	D
137. Pentachloroethane	ND	300-<740	ND	ND	D
138. Pentachloronitrobenzene	NA	NA	ND	NA	NA
139. Pentachlorophenol	ND	ND	ND	ND	ND
140. Phenacetin	NA	NA	ND	NA	NA
141. Phenanthrene	NA	NA	11-21	NA	NA
142. Phenol	NA	NA	ND	NA	NA
220. Phthalic anhydride	NA	NA	NA	NA	NA
143. 2-Picoline	NA	NA	ND	NA	NA
144. Pronamide	NA	NA	ND	NA	NA
145. Pyrene	NA	NA	ND	NA	NA
146. Resorcinol	NA	NA	ND	NA	NA
147. Safrole	NA	NA	ND	NA	NA
148. 1,2,4,5-Tetrachlorobenzene	ND	ND	<20-86	ND	D
149. 2,3,4,6-Tetrachlorophenol	ND	ND	ND	ND	ND
150. 1,2,4-Trichlorobenzene	ND	ND	<20-100	ND	D
151. 2,4,5-Trichlorophenol	ND	ND	ND	ND	ND
152. 2,4,6-Trichlorophenol	ND	ND	ND	ND	ND
153. Tris(2,3-dibromopropyl)phosphate	NA	NA	ND	NA	NA
Metals					
154. Antimony	NA	NA	ND	NA	NA
155. Arsenic	NA	NA	<0.2-1.2	NA	NA
156. Barium	NA	NA	<0.9-0.97	NA	NA
157. Beryllium	NA	NA	ND	NA	NA
158. Cadmium	NA	NA	<0.3-0.63	NA	NA
159. Chromium (total)	NA	NA	1.8-5.3	NA	NA
221. Chromium (hexavalent)	NA	NA	ND	NA	NA
160. Copper	NA	NA	<1.0-3.6	NA	NA
161. Lead	NA	NA	2.3-3.5	NA	NA
162. Mercury	NA	NA	ND	NA	NA
163. Nickel	NA	NA	2.2-6.0	NA	NA
164. Selenium	NA	NA	ND	NA	NA

NA - Not analyzed.
ND - Not detected.
D - This constituent was detected in the untreated waste. The concentration range detected is available in the confidential portion of the Administrative Record for this rulemaking.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS PRESENT IN UNTREATED K016, K018-K020, K030 WASTES

	K016 Detection Status (mg/kg)	K018 Detection Status (mg/kg)	K019 Detection Status (mg/kg)	K020 Detection Status (mg/kg)	K030 Detection Status (mg/kg)
Metals (Cont.)					
165. Silver	NA	NA	ND	NA	NA
166. Thallium	NA	NA	ND	NA	NA
167. Vanadium	NA	NA	ND	NA	NA
168. Zinc	NA	NA	4.4-9.4	NA	NA
Inorganics					
169. Cyanide	NA	NA	ND	NA	NA
170. Fluoride	NA	NA	ND	NA	NA
171. Sulfide	NA	NA	790	NA	NA
Organochlorine Pesticides					
172. Aldrin	NA	NA	NA	NA	NA
173. alpha-BHC	NA	NA	NA	NA	NA
174. beta-BHC	NA	NA	NA	NA	NA
175. delta-BHC	NA	NA	NA	NA	NA
176. gamma-BHC	NA	NA	NA	NA	NA
177. Chlordane	NA	NA	NA	NA	NA
178. DDD	NA	NA	NA	NA	NA
179. DDE	NA	NA	NA	NA	NA
180. DDT	NA	NA	NA	NA	NA
181. Dieldrin	NA	NA	NA	NA	NA
182. Endosulfan I	NA	NA	NA	NA	NA
183. Endosulfan II	NA	NA	NA	NA	NA
184. Endrin	NA	NA	NA	NA	NA
185. Endrin aldehyde	NA	NA	NA	NA	NA
186. Heptachlor	NA	NA	NA	NA	NA
187. Heptachlor epoxide	NA	NA	NA	NA	NA
188. Isodrin	NA	NA	NA	NA	NA
189. Kepone	NA	NA	NA	NA	NA
190. Methoxychlor	NA	NA	NA	NA	NA
191. Toxaphene	NA	NA	NA	NA	NA

NA - Not analyzed.
ND - Not detected.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS PRESENT IN UNTREATED K016, K018-K020, K030 WASTES

	K016 Detection Status (mg/kg)	K018 Detection Status (mg/kg)	K019 Detection Status (mg/kg)	K020 Detection Status (mg/kg)	K030 Detection Status (mg/kg)
Phenoxyacetic Acid Herbicides					
192. 2,4-Dichlorophenoxyacetic acid	NA	NA	NA	NA	NA
193. Silvex	NA	NA	NA	NA	NA
194. 2,4,5-T	NA	NA	NA	NA	NA
Organophosphorus Insecticides					
195. Disulfoton	NA	NA	NA	NA	NA
196. Famphur	NA	NA	NA	NA	NA
197. Methyl parathion	NA	NA	NA	NA	NA
198. Parathion	NA	NA	NA	NA	NA
199. Phorate	NA	NA	NA	NA	NA
PCBs					
200. Aroclor 1016	NA	NA	NA	NA	NA
201. Aroclor 1221	NA	NA	NA	NA	NA
202. Aroclor 1232	NA	NA	NA	NA	NA
203. Aroclor 1242	NA	NA	NA	NA	NA
204. Aroclor 1248	NA	NA	NA	NA	NA
205. Aroclor 1254	NA	NA	NA	NA	NA
206. Aroclor 1260	NA	NA	NA	NA	NA
Dioxins and Furans					
207. Hexachlorodibenzo-p-dioxins	NA	NA	NA	NA	NA
208. Hexachlorodibenzofuran	NA	NA	NA	NA	NA
209. Pentachlorodibenzo-p-dioxins	NA	NA	NA	NA	NA
210. Pentachlorodibenzofuran	NA	NA	NA	NA	NA
211. Tetrachlorodibenzo-p-dioxins	NA	NA	NA	NA	NA
212. Tetrachlorodibenzofuran	NA	NA	NA	NA	NA
213. 2,3,7,8-Tetrachlorodibenzo-p-dioxin	NA	NA	NA	NA	NA

NA - Not analyzed.
ND - Not detected.

Table 6-2

BDAT LIST CONSTITUENTS CONSIDERED FOR REGULATION*

NONWASTEWATERS				
K016	K018	K019	K020	K030
42. Tetrachloroethene	12. Chloroethane	7. Carbon tetrachloride	23. 1,2-Dichloroethane	42. Tetrachloroethene
110. Hexachlorobenzene	15. Chloromethane	9. Chlorobenzene	41. 1,1,2,2-Tetrachloroethane	87. o-Dichlorobenzene
111. Hexachlorobutadiene	22. 1,1-Dichloroethane	14. Chloroform	42. Tetrachloroethene	88. p-Dichlorobenzene
112. Hexachlorocyclopentadiene	23. 1,2-Dichloroethane	22. 1,1-Dichloroethane	46. 1,1,2-Trichloroethane	111. Hexachlorobutadiene
113. Hexachloroethane	45. 1,1,1-Trichloroethane	23. 1,2-Dichloroethane		112. Hexachlorocyclopentadiene
	46. 1,1,2-Trichloroethane	41. 1,1,2,2-Tetrachloroethane		113. Hexachloroethane
	110. Hexachlorobenzene	42. Tetrachloroethene		115. Hexachloropropene
	111. Hexachlorobutadiene	45. 1,1,1-Trichloroethane		136. Pentachlorobenzene
	113. Hexachloroethane	46. 1,1,2-Trichloroethane		137. Pentachloroethane
	137. Pentachloroethane	47. Trichloroethene		148. 1,2,4,5-Tetrachlorobenzene
		68. Bis(2-chloroethyl)ether		150. 1,2,4-Trichlorobenzene
		70. Bis(2-ethylhexyl)phthalate		
		88. p-Dichlorobenzene		
		98. Di-n-butyl phthalate		
		109. Fluorene		
		110. Hexachlorobenzene		
		111. Hexachlorobutadiene		
		113. Hexachloroethane		
		121. Naphthalene		
		136. Pentachlorobenzene		
		141. Phenanthrene		
		148. 1,2,4,5-Tetrachlorobenzene		
		150. 1,2,4-Trichlorobenzene		

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*All constituents on this list were detected in the K016, K018, K019, K020, or K030 wastes and were either selected for regulation (as shown in Table 5-3) or are believed to be controlled by regulation of another constituent.

Table 6-2 (Continued)

BDAT LIST CONSTITUENTS CONSIDERED FOR REGULATION*

WASTEWATERS

K016

42. Tetrachloroethene
110. Hexachlorobenzene
111. Hexachlorobutadiene
112. Hexachlorocyclopentadiene
113. Hexachloroethane

K018

12. Chloroethane
15. Chloromethane
22. 1,1-Dichloroethane
23. 1,2-Dichloroethane
45. 1,1,1-Trichloroethane
46. 1,1,2-Trichloroethane
110. Hexachlorobenzene
111. Hexachlorobutadiene
113. Hexachloroethane
137. Pentachloroethane

K019

7. Carbon tetrachloride
9. Chlorobenzene
14. Chloroform
21. Dichlorodifluoromethane
22. 1,1-Dichloroethane
23. 1,2-Dichloroethane
41. 1,1,2,2-Tetrachloroethane
42. Tetrachloroethene
43. Toluene
45. 1,1,1-Trichloroethane
46. 1,1,2-Trichloroethane
47. Trichloroethene
68. Bis(2-chloroethyl)ether
88. p-Dichlorobenzene
98. Di-n-butyl phthalate
109. Fluorene
110. Hexachlorobenzene
111. Hexachlorobutadiene
113. Hexachloroethane
121. Naphthalene
136. Pentachlorobenzene
141. Phenanthrene
148. 1,2,4,5-Tetrachlorobenzene
150. 1,2,4-Trichlorobenzene

K020

23. 1,2-Dichloroethane
41. 1,1,2,2-Tetrachloroethane
42. Tetrachloroethene
46. 1,1,2-Trichloroethane

K030

42. Tetrachloroethene
87. o-Dichlorobenzene
88. p-Dichlorobenzene
111. Hexachlorobutadiene
112. Hexachlorocyclopentadiene
113. Hexachloroethane
115. Hexachloropropene
136. Pentachlorobenzene
137. Pentachloroethane
148. 1,2,4,5-Tetrachlorobenzene
150. 1,2,4-Trichlorobenzene

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*All constituents on this list were detected in the K016, K018, K019, K020, or K030 wastes and were either selected for regulation under the selection method considered for the final rule (as shown in Table 5-4) or are believed to be controlled by regulation of another constituent.

Table 6-3

BDAT LIST CONSTITUENTS SELECTED FOR REGULATION

NONWASTEWATERS

K016	K018	K019	K020	K030
42. Tetrachloroethene	12. Chloroethane	9. Chlorobenzene	23. 1,2-Dichloroethane	42. Tetrachloroethene
110. Hexachlorobenzene	22. 1,1-Dichloroethane	14. Chloroform	41. 1,1,2,2-Tetrachloroethane	111. Hexachlorobutadiene
111. Hexachlorobutadiene	23. 1,2-Dichloroethane	23. 1,2-Dichloroethane	42. Tetrachloroethene	113. Hexachloroethane
112. Hexachlorocyclopentadiene	45. 1,1,1-Trichloroethane	42. Tetrachloroethene		115. Hexachloropropene
113. Hexachloroethane	110. Hexachlorobenzene	45. 1,1,1-Trichloroethane		136. Pentachlorobenzene
	111. Hexachlorobutadiene	68. Bis(2-chloroethyl)ether		137. Pentachloroethane
	113. Hexachloroethane	113. Hexachloroethane		148. 1,2,4,5-Tetrachlorobenzene
	137. Pentachloroethane	121. Naphthalene		150. 1,2,4-Trichlorobenzene
		141. Phenanthrene		
		150. 1,2,4-Trichlorobenzene		

Table 6-4

BDAT LIST CONSTITUENTS SELECTED FOR REGULATION

WASTEWATERS

	K016		K018		K019		K020		K030
42.	Tetrachloroethene	12.	Chloroethane	9.	Chlorobenzene	23.	1,2-Dichloroethane	42.	Tetrachloroethene
110.	Hexachlorobenzene	15.	Chloromethane	14.	Chloroform	41.	1,1,2,2-Tetrachloroethane	87.	o-Dichlorobenzene
111.	Hexachlorobutadiene	22.	1,1-Dichloroethane	23.	1,2-Dichloroethane	42.	Tetrachloroethene	88.	p-Dichlorobenzene
112.	Hexachlorocyclopentadiene	23.	1,2-Dichloroethane	42.	Tetrachloroethene			111.	Hexachlorobutadiene
113.	Hexachloroethane	45.	1,1,1-Trichloroethane	45.	1,1,1-Trichloroethane			113.	Hexachloroethane
		110.	Hexachlorobenzene	68.	Bis(2-chloroethyl)ether			137.	Pentachloroethane
		111.	Hexachlorobutadiene	88.	p-Dichlorobenzene			148.	1,2,4,5-Tetrachlorobenzene
		137.	Pentachloroethane	109.	Fluorene			150.	1,2,4-Trichlorobenzene
				113.	Hexachloroethane				
				121.	Naphthalene				
				141.	Phenanthrene				
				148.	1,2,4,5-Tetrachlorobenzene				
				150.	1,2,4-Trichlorobenzene				

7.0 CALCULATION OF TREATMENT STANDARDS

In Section 5.0 of this document, the best demonstrated and available technology for treatment of K016, K018, K019, K020, and K030 was chosen based on available performance data. In Section 6.0, the regulated constituents were selected in order to ensure effective treatment of the wastes. The purpose of Section 7.0 is to calculate treatment standards for each of the regulated constituents using the available treatment data from the BDAT treatment technology. Included in this section is a step-by-step discussion of the calculation of treatment standards for the nonwastewater and wastewater forms of K016, K018, K019, K020, and K030.

Rotary kiln incineration was determined to be BDAT (see Section 5.0) for K016, K018, K019, K020, and K030. Rotary kiln incineration generally results in the generation of two treatment residuals: ash (a nonwastewater form of K016, K018, K019, K020, and K030) and combustion gas scrubber water (a wastewater form of K016, K018, K019, K020, and K030). The best measure of performance for a destruction technology, such as rotary kiln incineration, is the total amount of constituent remaining after treatment. Therefore, BDAT treatment standards for organic constituents were calculated based on total constituent concentration data.

7.1 Calculation of Treatment Standards for Nonwastewater Forms of K016, K018, K019, K020, and K030

K019

The treatment standards for nonwastewater forms of K019 were calculated using six data sets from rotary kiln incineration of K019 waste. Table 7-1 presents the concentration values for organic constituents in the treatment residual (ash) resulting from rotary kiln incineration of K019 at plant A. Values are presented for constituents detected in the untreated K019 that were used in development of treatment standards for K016, K018, K019, K020, and K030 nonwastewaters. The concentration data presented in Table 7-1 have been corrected to account for analytical recovery as described in Section 5.0.

Nonwastewater treatment standards were calculated for each regulated constituent for K019 as shown in Table 7-4. The following three steps were used to calculate the treatment standards: (1) The arithmetic average of the corrected treatment values for each regulated constituent was calculated using the six data points presented in Table 7-1. (2) Using these same data, a variability factor was calculated that represents the variability inherent in the performance of the treatment system, collection of treated samples, and analysis of samples. Where concentrations in the treated waste were reported as less than or equal to the detection limit for all the data points in the data set, variability is still expected since the actual concentrations could range from 0 to the detection limit. In these cases, the Agency assumed a lognormal distribution of data points between the detection limit and a value

1/10 of the detection limit and calculated a variability factor of 2.8. (3) The treatment standard for each regulated constituent was calculated by multiplying the arithmetic average of the corrected treatment values by the variability factor. The analytical methods for analysis of each regulated constituent in K019 are included in Table 7-4. A detailed discussion of these analytical methods is presented in Appendix D (Analytical QA/QC).

K016, K018, K020, and K030

Treatment performance data from rotary kiln incineration of K016, K018, K020, and K030 are not available. Therefore, the Agency is transferring performance data from the treatment of K019 at plant A to K016, K018, K020, and K030. The calculations of treatment standards for K016, K018, K020, and K030 are presented in Tables 7-2, 7-3, 7-5, and 7-6, respectively. The transfer of treatment data is supported by the determination that K016, K018, K019, K020, and K030 represent a single waste treatability group, as discussed in Section 2.0. The determination of the waste treatability group is based on the similarity in composition of the untreated wastes, the fact that all of these wastes are generated by the organic chemicals industry, and the Agency's belief that constituents present in these wastes can be treated to similar concentrations using the same technology.

Where treatment data are available from treatment of K019 for a regulated constituent in K016, K018, K020, and K030, the data were transferred to that constituent to calculate the treatment standard for each waste code. For example, 1,1-dichloroethane was selected for regulation in K018.

1,1-Dichloroethane was detected in the untreated K019 at a concentration of 2,200 ppm and was treated to not detect values in the treatment residual (kiln ash residue) from treatment of K019 at plant A. Treatment data (in this case, not detect values) for 1,1-dichloroethane from K019 were transferred to 1,1-dichloroethane in K018 to calculate the treatment standard. 1,1-Dichloroethane was not selected for regulation in K019, however, because it was found in lower concentrations in the untreated K019 waste compared with concentrations of other constituents that were selected for regulation and because it is believed to be adequately controlled by incineration of other constituents that were selected for regulation. Treatment performance data were transferred in this way for most organic constituents in K016, K018, K020, and K030.

Treatment performance data were not available from treatment of K019 at plant A for some regulated organic constituents in K016, K018, K020, and K030. This is because the constituents selected for regulation for each waste code are based on available waste characterization data. Not all regulated constituents in K016, K018, K020, and K030 were detected in the K019 treated at plant A. The Agency believes that it would be inappropriate to base treatment standards on not detect values in the treatment residual of K019 if the constituent was not detected in the untreated K019. In such cases, data were transferred to that organic constituent from another organic constituent that was detected in the untreated K019 based on the boiling points of the constituents. (Boiling point is a waste characteristic that affects the performance of rotary kiln incineration as discussed in Section 3.4. Appendix E presents information on waste characteristics that affect performance.) The constituent with the same or the closest higher boiling point for which the Agency had treatment performance data from K019 at plant A was selected for transfer of data. Cases where such a transfer of data occurred are summarized below and are noted on Tables 7-2, 7-3, 7-5, and 7-6, which show the calculations of the treatment standards for K016, K018, K020, and K030, respectively.

12. Chloroethane (K018). The treatment standard for chloroethane (bp 12°C) in K018 is based on data transferred from treatment of chloroform (bp 61°C) in K019. Based on the discussion of waste characteristics affecting treatment performance of rotary kiln incineration in Section 3.4, the Agency expects that chloroethane can be treated to concentration levels as low or lower than chloroform.

41. 1,1,2,2-Tetrachloroethane (K020). The treatment standard for 1,1,2,2-tetrachloroethane (bp 147°C) in K020 is based on data transferred from treatment of bis(2-chloroethyl)ether (bp 178°C) in K019. Based on the discussion of waste characteristics affecting treatment performance of rotary kiln incineration in Section 3.4, the Agency expects that 1,1,2,2-tetrachloroethane can be treated to concentration levels as low or lower than bis(2-chloroethyl)ether.

111. Hexachlorobutadiene (K016, K018, K030). The treatment standard for hexachlorobutadiene (bp 215°C) in K016, K018, and K030 is based on data transferred from treatment of naphthalene (bp 218°C) in K019. Based on

the discussion of waste characteristics affecting treatment performance of rotary kiln incineration in Section 3.4, the Agency expects that hexachlorobutadiene can be treated to concentration levels as low or lower than naphthalene.

112. Hexachlorocyclopentadiene (K016). The treatment standard for hexachlorocyclopentadiene (bp 234°C) in K016 is based on data transferred from treatment of phenanthrene (bp 340°C) in K019. Based on the discussion of waste characteristics affecting treatment performance of rotary kiln incineration in Section 3.4, the Agency expects that hexachlorocyclopentadiene can be treated to concentration levels as low or lower than phenanthrene.

115. Hexachloropropene (K030). The treatment standard for hexachloropropene (bp 209°C) in K030 is based on data transferred from treatment of 1,2,4-trichlorobenzene (bp 213°C) in K019. Based on the discussion of waste characteristics affecting treatment performance of rotary kiln incineration in Section 3.4, the Agency expects that hexachloropropene can be treated to concentration levels as low or lower than 1,2,4-trichlorobenzene.

137. Pentachloroethane (K018, K030). The treatment standard for pentachloroethane (bp 161°C) in K018 and K030 is based on data transferred from treatment of bis(2-chloroethyl)ether (bp 178°C) in K019. Based on the discussion of waste characteristics affecting treatment performance of rotary kiln incineration in Section 3.4, the Agency expects that pentachloroethane

can be treated to concentration levels as low or lower than bis(2-chloroethyl)ether.

7.2 Calculation of Treatment Standards for Wastewater Forms of K016, K018, K019, K020, and K030

K019

The treatment standards for wastewater forms of K019 were calculated using six data sets from rotary kiln incineration of K019. Table 7-7 presents the concentration values for organic constituents in the treatment residual (scrubber water) resulting from rotary kiln incineration of K019 at plant A. Values are presented for constituents (detected in the untreated K019) that were used in development of treatment standards for K016, K018, K019, K020, and K030 wastewaters. The concentration data presented in Table 7-7 have been corrected to account for analytical recovery as described in Section 5.0.

Wastewater treatment standards were calculated for each regulated constituent for K019 as shown in Table 7-10. The following three steps were used to calculate the treatment standards: (1) The arithmetic average of the corrected treatment values for each regulated constituent was calculated using the six data points presented in Table 7-7. (2) Using these same data, a variability factor was calculated that represents the variability inherent in the performance of the treatment system, collection of treated samples, and analysis of samples. Where concentrations in the treated waste were reported

as less than or equal to the detection limit for all the data points in the data set, variability is still expected since the actual concentrations could range from 0 to the detection limit. In these cases, the Agency assumed a lognormal distribution of data points between the detection limit and a value 1/10 of the detection limit and calculated a variability factor of 2.8.
(3) The treatment standard for each regulated constituent was calculated by multiplying the arithmetic average of the corrected treatment values by the variability factor. The analytical methods upon which the treatment standards for K019 are based are included in Table 7-10. A detailed discussion of these analytical methods is presented in Appendix D (Analytical QA/QC).

K016, K018, K020, and K030

Treatment performance data from rotary kiln incineration of K016, K018, K020, and K030 are not available. Therefore, the Agency is transferring data from the treatment of K019 at plant A to K016, K018, K020, and K030. The calculations of treatment standards for K016, K018, K020, and K030 are presented in Tables 7-8, 7-9, 7-11, and 7-12, respectively. The transfer of treatment data is supported by the determination that K016, K018, K019, K020, and K030 represent a single waste treatability group, as discussed in Section 2.0. The determination of the waste treatability group is based on the similarity in composition of the untreated wastes, the fact that all of these wastes are generated by the organic chemicals industry, and the Agency's belief that constituents present in these wastes can be treated to similar concentrations using the same technology.

Where treatment data are available from treatment of K019 for a regulated constituent in K016, K018, K020, and K030, the data were transferred to that constituent to calculate the treatment standard for each waste code. For example, 1,1-dichloroethane was selected for regulation in K018. 1,1-Dichloroethane was detected in the untreated K019 at a concentration of 2,200 ppm and was treated to not detect values in the treatment residual (combustion gas scrubber water) from treatment of K019 at plant A. Treatment data (in this case: not detect values) for 1,1-dichloroethane from K019 were transferred to 1,1-dichloroethane in K018 to calculate the treatment standard. 1,1-Dichloroethane was not selected for regulation in K019, however, because it was found in lower concentrations in the untreated K019 waste compared with concentrations of other constituents that were selected for regulation and because it is believed to be adequately controlled by incineration of other constituents that were selected for regulation. Treatment performance data were transferred in this way for most organic constituents in K016, K018, K020, and K030.

Treatment performance data were not available from treatment of K019 at plant A for some regulated organic constituents in K016, K018, K020, and K030. This is because the constituents selected for regulation for each waste code are based on available waste characterization data. Not all regulated constituents in K016, K018, K020, and K030 were detected in the K019 treated at plant A. The Agency believes that it would be inappropriate to base treatment standards on not detect values in the treatment residual of K019 if the constituent was not detected in the untreated K019. In such cases, data were transferred to that organic constituent from another organic constituent that was detected in the untreated K019 based on the bond dissociation energy of the constituents. (Bond dissociation energy (BDE) is a waste characteristic that affects the performance of rotary kiln incineration as discussed in Section 3.4.) The constituent with the same or the closest higher bond dissociation energy for which the Agency had treatment data from K019 at plant A was selected for transfer of data. Cases where such a transfer of data occurred are summarized below and are noted on Tables 7-8, 7-9, 7-11, and 7-12, which show the calculations of the treatment standards for K016, K018, K020, and K030, respectively.

12. Chloroethane (K018). The treatment standard for chloroethane (BDE 665 kcal/mol) in K018 is based on data transferred from treatment of bis(2-chloroethyl)ether (BDE 1,290 kcal/mol) in K019. Based on the discussion of waste characteristics affecting treatment performance of rotary kiln incineration in Section 3.4, the Agency expects that chloroethane can be treated to concentration levels as low or lower than bis(2-chloroethyl)ether.

15. Chloromethane (K018). The treatment standard for chloromethane (BDE 380 kcal/mol) in K018 is based on data transferred from treatment of tetrachloroethene (BDE 461 kcal/mol) in K019. Based on the discussion of waste characteristics affecting treatment performance of rotary kiln incineration in Section 3.4, the Agency expects that chloromethane can be treated to concentration levels as low or lower than tetrachloroethene.

41. 1,1,2,2-Tetrachloroethane (K020). The treatment standard for 1,1,2,2-tetrachloroethane (BDE 605 kcal/mol) in K020 is based on data transferred from treatment of 1,1,1-trichloroethane (BDE 625 kcal/mol) in K019. Based on the discussion of waste characteristics affecting treatment performance of rotary kiln incineration in Section 3.4, the Agency expects that 1,1,2,2-tetrachloroethane can be treated to concentration levels as low or lower than 1,1,1-trichloroethane.

87. o-Dichlorobenzene (K030). The treatment standard for o-dichlorobenzene (BDE 1,325 kcal/mol) in K030 is based on data transferred from treatment of p-dichlorobenzene (BDE 1,325 kcal/mol) in K019. Based on the discussion of waste characteristics affecting treatment performance of rotary kiln incineration in Section 3.4, the Agency expects that o-dichlorobenzene can be treated to concentration levels as low or lower than p-dichlorobenzene.

111. Hexachlorobutadiene (K016, K018, K030). The treatment standard for hexachlorobutadiene (BDE 853 kcal/mol) in K016, K018, and K030 is based on data transferred from treatment of bis(2-chloroethyl)ether (BDE 1,290 kcal/mol) in K019. Based on the discussion of waste characteristics affecting treatment performance of rotary kiln incineration in Section 3.4, the Agency expects that hexachlorobutadiene can be treated to concentration levels as low or lower than bis(2-chloroethyl)ether.

112. Hexachlorocyclopentadiene (K016). The treatment standard for hexachlorocyclopentadiene (BDE 1,020 kcal/mol) in K016 is based on data

transferred from treatment of bis(2-chloroethyl)ether (BDE 1,290 kcal/mol) in K019. Based on the discussion of waste characteristics affecting treatment performance of rotary kiln incineration in Section 3.4, the Agency expects that hexachlorocyclopentadiene can be treated to concentration levels as low or lower than bis(2-chloroethyl)ether.

137. Pentachloroethane (K018, K030). The treatment standard for pentachloroethane (BDE 585 kcal/mol) in K018 and K030 is based on data transferred from treatment of 1,1,1-trichloroethane (BDE 625 kcal/mol) in K019. Based on the discussion of waste characteristics affecting treatment performance of rotary kiln incineration in Section 3.4, the Agency expects that pentachloroethane can be treated to concentration levels as low or lower than 1,1,1-trichloroethane.

Table 7-1

CORRECTED TOTAL CONCENTRATION DATA FOR ORGANICS IN ROTARY KILN INCINERATOR ASH FROM TREATMENT OF K019

Constituent*	Corrected Concentrations** in the Treated Waste, ppm 1	2	3	4	5	6
Volatiles						
9. Chlorobenzene	2.02	2.02	2.02	2.02	2.02	2.02
14. Chloroform	2.13	2.13	2.13	2.13	2.13	2.13
22. 1,1-Dichloroethane	2.13	2.13	2.13	2.13	2.13	2.13
23. 1,2-Dichloroethane	2.13	2.13	2.13	2.13	2.13	2.13
42. Tetrachloroethene	2.13	2.13	2.13	2.13	2.13	2.13
45. 1,1,1-Trichloroethane	2.13	2.13	2.13	2.13	2.13	2.13
Semivolatiles						
68. Bis(2-chloroethyl)ether	2.00	2.00	2.00	2.00	2.00	2.00
110. Hexachlorobenzene	10	10	10	10	10	10
113. Hexachloroethane	10	10	10	10	10	10
121. Naphthalene	2.00	2.00	2.00	2.00	2.00	2.00
136. Pentachlorobenzene	10	10	10	10	10	10
141. Phenanthrene	2.00	2.00	2.00	2.00	2.00	2.00
148. 1,2,4,5-Tetrachlorobenzene	5.00	5.00	5.00	5.00	5.00	5.00
150. 1,2,4-Trichlorobenzene	6.67	6.67	6.67	6.67	6.67	6.67

*Constituents present in untreated K019.

**Constituent concentrations have been adjusted to account for analytical recoveries ("corrected") as discussed in Section 5.0.

Table 7-2

CALCULATION OF NONWASTEWATER TREATMENT STANDARDS FOR K016

Regulated Constituent (SW-846 Method Number)[1]		K019 Constituent From Which Treatment Data Were Transferred	Untreated Concentration* (ppm)	Arithmetic Average of Corrected Treatment Values** (ppm)	Variability Factor (VF)	Treatment Standard** (Average x VF) (ppm)
Volatiles (8240) (Total Concentration)						
42.	Tetrachloroethene	Tetrachloroethene	6.00-78,000	2.13	2.8	6.0
Semivolatiles (8270) (Total Concentration)						
110.	Hexachlorobenzene	Hexachlorobenzene	60-87	10	2.8	28
111.	Hexachlorobutadiene	Naphthalene	314-470	2.00	2.8	5.6
112.	Hexachlorocyclopentadiene	Phenanthrene	11-21	2.00	2.8	5.6
113.	Hexachloroethane	Hexachloroethane	85-120	10	2.8	28

[1] For detailed discussion of the analytical methods upon which these treatment standards are based, see Appendix D (QA/QC section).

*This is the untreated concentration in K019 of each constituent from which treatment data were transferred.

**The values shown on this table for arithmetic averages and treatment standards have been rounded to show significant figures only.

Table 7-3

CALCULATION OF NONWASTEWATER TREATMENT STANDARDS FOR K018

Regulated Constituent (SW-846 Method Number)[1]	K019 Constituent From Which Treatment Data Were Transferred	Untreated Concentration* (ppm)	Arithmetic Average of Corrected Treatment Values** (ppm)	Variability Factor (VF)	Treatment Standard** (Average x VF) (ppm)
Volatiles (8240) (Total Concentration)					
12. Chloroethane	Chloroform	4,600-6,000	2.13	2.8	6.0
22. 1,1-Dichloroethane	1,1-Dichloroethane	<2,000-2,200	2.13	2.8	6.0
23. 1,2-Dichloroethane	1,2-Dichloroethane	87,000-122,000	2.13	2.8	6.0
45. 1,1,1-Trichloroethane	1,1,1-Trichloroethane	2,200-3,210	2.13	2.8	6.0
Semivolatiles (8270) (Total Concentration)					
110. Hexachlorobenzene	Hexachlorobenzene	60-87	10	2.8	28
111. Hexachlorobutadiene	Naphthalene	314-470	2.00	2.8	5.6
113. Hexachloroethane	Hexachloroethane	85-120	10	2.8	28
137. Pentachloroethane	Bis(2-chloroethyl)ether	280-340	2.00	2.8	5.6

[1] For detailed discussion of the analytical methods upon which these treatment standards are based, see Appendix D (QA/QC section).

*This is the untreated concentration in K019 of each constituent from which treatment data were transferred.

**The values shown on this table for arithmetic averages and treatment standards have been rounded to show significant figures only.

Table 7-4

CALCULATION OF NONWASTEWATER TREATMENT STANDARDS FOR K019

Regulated Constituent (SW-846 Method Number)[1]	Untreated K019 at Plant A* (ppm)	Arithmetic Average of Corrected Treatment Values** (ppm)	Variability Factor (VF)	Treatment Standard** (Average x VF) (ppm)
Volatiles (8240) (Total Concentration)				
9. Chlorobenzene	<2000-3000	2.02	2.8	6.0
14. Chloroform	4600-6000	2.13	2.8	6.0
23. 1,2-Dichloroethane	87000-122000	2.13	2.8	6.0
42. Tetrachloroethene	6000-78000	2.13	2.8	6.0
45. 1,1,1-Trichloroethane	2200-3210	2.13	2.8	6.0
Semivolatiles (8270) (Total Concentration)				
68. Bis(2-chloroethyl)ether	280-340	2.00	2.8	5.6
113. Hexachloroethane	85-120	10	2.8	28
121. Naphthalene	314-470	2.00	2.8	5.6
141. Phenanthrene	11-21	2.00	2.8	5.6
150. 1,2,4-Trichlorobenzene	65-100	6.67	2.8	19

*Concentration values for the untreated waste have not been corrected for recovery.

[1] For detailed discussion of the analytical methods upon which these treatment standards are based, see Appendix D (QA/QC section).

**The values shown on this table for arithmetic averages and treatment standards have been rounded to show significant figures only.

Table 7-5

CALCULATION OF NONWASTEWATER TREATMENT STANDARDS FOR K020

Regulated Constituent (SW-846 Method Number)[1]	K019 Constituent From Which Treatment Data Were Transferred	Untreated Concentration* (ppm)	Arithmetic Average of Corrected Treatment Values** (ppm)	Variability Factor (VF)	Treatment Standard** (Average x VF) (ppm)
Volatiles (8240) (Total Concentration)					
23. 1,2-Dichloroethane	1,2-Dichloroethane	87,000-122,000	2.13	2.8	6.0
41. 1,1,2,2-Tetrachloroethane	Bis(2-chloroethyl)-ether	280-340	2.00	2.8	5.6
42. Tetrachloroethene	Tetrachloroethene	6,000-78,000	2.13	2.8	6.0
Semivolatiles (8270) (Total Concentration)					

No semivolatile organics are being proposed for regulation for this waste code.

[1] For detailed discussion of the analytical methods upon which these treatment standards are based, see Appendix D (QA/QC section).

* This is the untreated concentration in K019 of each constituent from which treatment data were transferred.

**The values shown on this table for arithmetic averages and treatment standards have been rounded to show significant figures only.

Table 7-6

CALCULATION OF NONWASTEWATER TREATMENT STANDARDS FOR K030

Regulated Constituent (SW-846 Method Number)[1]	K019 Constituent From Which Treatment Data Were Transferred	Untreated Concentration* (ppm)	Arithmetic Average of Corrected Treatment Values** (ppm)	Variability Factor (VF)	Treatment Standard** (Average x VF) (ppm)
Volatiles (8240) (Total Concentration)					
42. Tetrachloroethene	Tetrachloroethene	6,000-78,000	2.13	2.8	6.0
Semivolatiles (8270) (Total Concentration)					
111. Hexachlorobutadiene	Naphthalene	314-470	2.00	2.8	5.6
113. Hexachloroethane	Hexachloroethane	85-120	10	2.8	28
115. Hexachloropropene	1,2,4-Trichlorobenzene	65-100	6.67	2.8	19
136. Pentachlorobenzene	Pentachlorobenzene	51-65	10	2.8	28
137. Pentachloroethane	Bis(2-chloroethyl)ether	280-340	2.00	2.8	5.6
148. 1,2,4,5-Tetrachlorobenzene	1,2,4,5-Tetrachlorobenzene	62-86	5.00	2.8	14
150. 1,2,4-Trichlorobenzene	1,2,4-Trichlorobenzene	65-100	6.67	2.8	19

[1] For detailed discussion of the analytical methods upon which these treatment standards are based, see Appendix D (QA/QC section).

* This is the untreated concentration in K019 of each constituent from which treatment data were transferred.

**The values shown on this table for arithmetic averages and treatment standards have been rounded to show significant figures only.

Table 7-7

CORRECTED TOTAL COMPOSITION DATA FOR ORGANICS IN ROTARY KILN SCRUBBER WATER FROM TREATMENT OF K019

Constituent*	Corrected Concentration in the Treated Waste, ppm					
	1	2	3	4	5	6
Volatiles						
9. Chlorobenzene	0.002	0.002	0.002	0.002	0.002	0.002
14. Chloroform	0.003	0.003	0.003	0.003	0.003	0.003
22. 1,1-Dichloroethane	0.003	0.003	0.003	0.003	0.003	0.003
23. 1,2-Dichloroethane	0.003	0.003	0.003	0.003	0.003	0.003
42. Tetrachloroethene	0.003	0.003	0.003	0.003	0.003	0.003
45. 1,1,1-Trichloroethane	0.003	0.003	0.003	0.003	0.003	0.003
Semivolatiles						
68. Bis(2-chloroethyl)ether	0.002	0.002	0.002	0.002	0.002	0.002
88. p-Dichlorobenzene	0.003	0.003	0.003	0.003	0.003	0.003
109. Fluorene	0.002	0.002	0.002	0.002	0.002	0.002
110. Hexachlorobenzene	0.012	0.012	0.012	0.012	0.012	0.012
113. Hexachloroethane	0.012	0.012	0.012	0.012	0.012	0.012
121. Naphthalene	0.002	0.002	0.002	0.002	0.002	0.002
141. Phenanthrene	0.002	0.002	0.002	0.002	0.002	0.002
148. 1,2,4,5-Tetrachlorobenzene	0.006	0.006	0.006	0.006	0.006	0.006
150. 1,2,4-Trichlorobenzene	0.008	0.008	0.008	0.008	0.008	0.008

*Constituents proposed for regulation and present in untreated K019.

Table 7-8

CALCULATION OF WASTEWATER TREATMENT STANDARDS FOR K016

Regulated Constituent (SW-846 Method Number)[1]	K019 Constituent From Which Treatment Data Were Transferred	Untreated Concentration* (ppm)	Arithmetic Average of Corrected Treatment Values** (ppm)	Variability Factor (VF)	Treatment Standard** (Average x VF)(ppm)
Volatiles (8240) (Total Concentration)					
42. Tetrachloroethene	Tetrachloroethene	6,000-78,000	0.003	2.8	0.007
Semivolatiles (8270) (Total Concentration					
110. Hexachlorobenzene	Hexachlorobenzene	60-87	0.012	2.8	0.033
111. Hexachlorobutadiene	Bis(2-chloroethyl)ether	280-340	0.002	2.8	0.007
112. Hexachlorocyclopentadiene	Bis(2-chloroethyl)ether	280-340	0.002	2.8	0.007
113. Hexachloroethane	Hexachloroethane	85-120	0.012	2.8	0.033

[1] For detailed discussion of the analytical methods upon which these treatment standards are based, see Appendix D (QA/QC section).

*This is the untreated concentration in K019 of each constituent from which treatment data were transferred.

**The values shown on this table for arithmetic averages and treatment standards have been rounded to show significant figures only.

Table 7-9

CALCULATION OF WASTEWATER TREATMENT STANDARDS FOR K018

Regulated Constituent (SW-846 Method Number)[1]	K019 Constituent From Which Treatment Data Were Transferred	Untreated Concentration* (ppm)	Arithmetic Average of Corrected Treatment Values** (ppm)	Variability Factor (VF)	Treatment Standard** (Average x VF)(ppm)
Volatiles (8240) (Total Concentration)					
12. Chloroethane	Bis(2-chloroethyl)ether	280-340	0.002	2.8	0.007
15. Chloromethane	Tetrachloroethene	6,000-78,000	0.003	2.8	0.007
22. 1,1-Dichloroethane	1,1-Dichloroethane	<2,000-2,200	0.003	2.8	0.007
23. 1,2-Dichloroethane	1,2-Dichloroethane	87,000-122,000	0.003	2.8	0.007
45. 1,1,1-Trichloroethane	1,1,1-Trichloroethane	2,200-3,210	0.003	2.8	0.007
Semivolatiles (8270) (Total Concentration)					
110. Hexachlorobenzene	Hexachlorobenzene	60-87	0.012	2.8	0.033
111. Hexachlorobutadiene	Bis(2-chloroethyl)ether	280-3,400	0.002	2.8	0.007
137. Pentachloroethane	1,1,1-Trichloroethane	2,200-3,210	0.003	2.8	0.007

[1] For detailed discussion of the analytical methods upon which these treatment standards are based, see Appendix D (QA/QC section).

*This is the untreated concentration in K019 of each constituent from which treatment data were transferred.

**The values shown on this table for arithmetic averages and treatment standards have been rounded to show significant figures only.

Table 7-10

CALCULATION OF WASTEWATER TREATMENT STANDARDS FOR K019

Regulated Constituent (SW-846 Method Number)[1]	Untreated K019 at Plant A* (ppm)	Arithmetic Average of Corrected Treatment Values** (ppm)	Variability Factor (VF)	Treatment Standard** (Average x VF)(ppm)
Volatiles (8240) (Total Concentration)				
9. Chlorobenzene	<2,000-3,000	0.002	2.8	0.006
14. Chloroform	4,600-6,000	0.003	2.8	0.007
23. 1,2-Dichloroethane	87,000-122,000	0.003	2.8	0.007
42. Tetrachloroethene	6,000-78,000	0.003	2.8	0.007
45. 1,1,1-Trichloroethane	2,200-3,210	0.003	2.8	0.007
Semivolatiles (8270) (Total Concentration)				
68. Bis(2-chloroethyl)ether	280-340	0.002	2.8	0.007
88. p-Dichlorobenzene	74-90	0.003	2.8	0.008
109. Fluorene	16-22	0.002	2.8	0.007
113. Hexachloroethane	85-120	0.012	2.8	0.033
121. Naphthalene	314-470	0.002	2.8	0.007
141. Phenanthrene	11-21	0.002	2.8	0.007
148. 1,2,4,5-Tetrachlorobenzene	62-86	0.006	2.8	0.017
150. 1,2,4-Trichlorobenzene	65-100	0.008	2.8	0.023

[1] For detailed discussion of the analytical methods upon which these treatment standards are based, see Appendix D (QA/QC section).

*Concentration values for the untreated waste have not been corrected for recovery.

**The values shown on this table for arithmetic averages and treatment standards have been rounded to show significant figures only.

Table 7-11

CALCULATION OF WASTEWATER TREATMENT STANDARDS FOR K020

Regulated Constituent (SW-846 Method Number)[1]	K019 Constituent From Which Treatment Data Were Transferred	Untreated Concentration* (ppm)	Arithmetic Average of Corrected Treatment Values** (ppm)	Variability Factor (VF)	Treatment Standard** (Average x VF)(ppm)
Volatiles (8240) (Total Concentration)					
23. 1,2-Dichloroethane	1,2-Dichloroethane	87,000-122,000	0.003	2.8	0.007
41. 1,1,2,2-Tetrachloroethane	1,1,1-Trichloroethane	2,200-3,210	0.003	2.8	0.007
42. Tetrachloroethene	Tetrachloroethene	6,000-78,000	0.003	2.8	0.007

Semivolatiles (8270)
Total Concentrations

No semivolatile organics are being regulated for this waste code.

[1] For detailed discussion of the analytical methods upon which these treatment standards are based, see Appendix D (QA/QC section).

*This is the untreated concentration in K019 of each constituent from which treatment data were transferred.

**The values shown on this table for arithmetic averages and treatment standards have been rounded to show significant figures only.

Table 7-12

CALCULATION OF WASTEWATER TREATMENT STANDARDS FOR K030

Regulated Constituent (SW-846 Method Number)[1]	K019 Constituent From Which Treatment Data Were Transferred	Untreated Concentration* (ppm)	Arithmetic Average of Corrected Treatment Values** (ppm)	Variability Factor (VF)	Treatment Standard** (Average x VF)(ppm)
Volatiles (8240) (Total Concentration)					
42. Tetrachloroethene	Tetrachloroethene	6,000-78,000	0.003	2.8	0.007
Semivolatiles (8270) (Total Concentration)					
87. o-Dichlorobenzene	p-Dichlorobenzene	74-90	0.003	2.8	0.008
88. p-Dichlorobenzene	p-Dichlorobenzene	74-90	0.003	2.8	0.008
111. Hexachlorobutadiene	Bis(2-chloroethyl)ether	280-340	0.002	2.8	0.007
113. Hexachloroethane	Hexachloroethane	85-120	0.012	2.8	0.033
137. Pentachloroethane	1,1,1-Trichloroethane	2,200-3,210	0.003	2.8	0.007
148. 1,2,4,5-Tetrachlorobenzene	1,2,4,5-Tetrachlorobenzene	62-86	0.006	2.8	0.017
150. 1,2,4-Trichlorobenzene	1,2,4-Trichlorobenzene	65-100	0.008	2.8	0.023

[1] For detailed discussion of the analytical methods upon which these treatment standards are based, see Appendix D (QA/QC section).

*This is the untreated concentration in K019 of each constituent from which treatment data were transferred.

**The values shown on this table for arithmetic averages and treatment standards have been rounded to show significant figures only.

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APPENDIX A

STATISTICAL METHODS

A.1 F Value Determination for ANOVA Test

A.2 Variability Factor

APPENDIX A

A.1 F Value Determination for ANOVA Test

As noted earlier in Section 1.0, EPA is using the statistical method known as analysis of variance in the determination of the level of performance that represents "best" treatment where more than one technology is demonstrated. This method provides a measure of the differences between data sets. If the differences are not statistically significant, the data sets are said to be homogeneous.

If the Agency found that the levels of performance for one or more technologies are not statistically different (i.e., the data sets are homogeneous), EPA would average the long term performance values achieved by each technology and then multiply this value by the largest variability factor associated with any of the acceptable technologies. If EPA found that one technology performs significantly better (i.e., the data sets are not homogeneous), BDAT would be the level of performance achieved by the best technology multiplied by its variability factor.

To determine whether any or all of the treatment performance data sets are homogeneous using the analysis of variance method, it is necessary to compare a calculated "F value" to what is known as a "critical value." (See Table A-1.) These critical values are available in most statistics texts (see, for example, *Statistical Concepts and Methods* by Bhattacharyya and Johnson, 1977, John Wiley Publications, New York).

Where the F value is less than the critical value, all treatment data sets are homogeneous. If the F value exceeds the critical value, it is necessary to perform a "pair wise F" test to determine if any of the sets are homogeneous. The "pair wise F" test must be done for all of the various combinations of data sets using the same method and equation as the general F test.

The F value is calculated as follows:

(i) All data are natural logtransformed.

(ii) The sum of the data points for each data set is computed (T_i).

(iii) The statistical parameter known as the sum of the squares between data sets (SSB) is computed:

$$SSB = \left[\sum_{i=1}^{k} \left(\frac{T_i^2}{n_i} \right) \right] - \left(\frac{\left[\sum_{i=1}^{k} T_i \right]^2}{N} \right)$$

where:

k = number of treatment technologies
n_i = number of data points for technology i
N = number of data points for all technologies
T_i = sum of natural logtransformed data points for each technology.

(iv) The sum of the squares within data sets (SSW) is computed:

$$SSW = \left[\sum_{i=1}^{k} \sum_{j=1}^{n_i} x^2_{i,j} \right] - \sum_{i=1}^{k} \left(\frac{T_i^2}{n_i} \right)$$

where:

$x_{i,j}$ = the natural logtransformed observations (j) for treatment technology (i).

(v) The degrees of freedom corresponding to SSB and SSW are calculated. For SSB, the degree of freedom is given by k-1. For SSW, the degree of freedom is given by N-k.

(vi) Using the above parameters, the F value is calculated as follows:

$$F = \frac{MSB}{MSW}$$

where:

MSB = SSB/(k-1) and
MSW = SSW/(N-k).

A computational table summarizing the above parameters is shown below.

Computational Table for the F Value

Source	Degrees of freedom	Sum of squares	Mean square	F
Between	K-1	SSB	MSB = SSB/k-1	MSB/MSW
Within	N-k	SSW	MSW = SSW/N-k	

Below are three examples of the ANOVA calculation. The first two represent treatment by different technologies that achieve statistically similar treatment; the last example represents a case where one technology achieves significantly better treatment than the other technology.

Table A-1

F Distribution at the 95 Percent Confidence Level

$F_{0.95}$

Denominator degrees of freedom	Numerator degrees of freedom 1	2	3	4	5	6	7	8	9
1	161.4	199.5	215.7	224.6	230.2	234.0	236.8	238.9	240.5
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04
120	3.92	3.07	2.68	2.45	2.29	2.17	2.09	2.02	1.96
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88

Example 1
Methylene Chloride

Steam stripping				Biological treatment			
Influent (µg/l)	Effluent (µg/l)	ln(effluent)	$[\ln(\text{effluent})]^2$	Influent (µg/l)	Effluent (µg/l)	ln(effluent)	$[\ln(\text{effluent})]^2$
1550.00	10.00	2.30	5.29	1960.00	10.00	2.30	5.29
1290.00	10.00	2.30	5.29	2568.00	10.00	2.30	5.29
1640.00	10.00	2.30	5.29	1817.00	10.00	2.30	5.29
5100.00	12.00	2.48	6.15	1640.00	26.00	3.26	10.63
1450.00	10.00	2.30	5.29	3907.00	10.00	2.30	5.29
4600.00	10.00	2.30	5.29				
1760.00	10.00	2.30	5.29				
2400.00	10.00	2.30	5.29				
4800.00	10.00	2.30	5.29				
12100.00	10.00	2.30	5.29				
Sum:							
-	-	23.18	53.76	-	-	12.46	31.79
Sample Size:							
10	10	10	-	5	5	5	-
Mean:							
3669	10.2	2.32	-	2378	13.2	2.49	-
Standard Deviation:							
3328.67	.63	.06	-	923.04	7.15	.43	-
Variability Factor:							
	1.15	-	-	-	2.48	-	-

ANOVA Calculations:

$$SSB = \left[\sum_{i=1}^{k} \left(\frac{T_i^2}{n_i} \right) \right] - \left(\frac{\left[\sum_{i=1}^{k} T_i \right]^2}{N} \right)$$

$$SSW = \left[\sum_{i=1}^{k} \sum_{j=1}^{n_i} x^2_{i,j} \right] - \sum_{i=1}^{k} \left(\frac{T_i^2}{n_i} \right)$$

$$MSB = SSB/(k-1)$$

$$MSW = SSW/(N-k)$$

Example 1 (continued)

$F = MSB/MSW$

where:

k = number of treatment technologies

n_i = number of data points for technology i

N = number of natural log transformed data points for all technologies

T_i = sum of log transformed data points for each technology

X_{ij} = the nat. log transformed observations (j) for treatment technology (i)

$n_1 = 10,\ n_2 = 5,\ N = 15,\ k = 2,\ T_1 = 23.18,\ T_2 = 12.46,\ T = 35.64,\ T^2 = 1270.21$

$T_1^2 = 537.31\quad T_2^2 = 155.25$

$$SSB = \left(\frac{537.31}{10} + \frac{155.25}{5}\right) - \frac{1270.21}{15} = 0.10$$

$$SSW = (53.76 + 31.79) - \left(\frac{537.31}{10} + \frac{155.25}{5}\right) = 0.77$$

$MSB = 0.10/1 = 0.10$

$MSW = 0.77/13 = 0.06$

$$F = \frac{0.10}{0.06} = 1.67$$

ANOVA Table

Source	Degrees of freedom	SS	MS	F
Between(B)	1	0.10	0.10	1.67
Within(W)	13	0.77	0.06	

The critical value of the F test at the 0.05 significance level is 4.67. Since the F value is less than the critical value, the means are not significantly different (i.e., they are homogeneous).

Note: All calculations were rounded to two decimal places. Results may differ depending upon the number of decimal places used in each step of the calculations.

Example 2
Trichloroethylene

	Steam stripping				Biological treatment		
Influent (μg/l)	Effluent (μg/l)	ln(effluent)	$[\ln(\text{effluent})]^2$	Influent (μg/l)	Effluent (μg/l)	ln(effluent)	$[\ln(\text{effluent})]^2$
1650.00	10.00	2.30	5.29	200.00	10.00	2.30	5.29
5200.00	10.00	2.30	5.29	224.00	10.00	2.30	5.29
5000.00	10.00	2.30	5.29	134.00	10.00	2.30	5.29
1720.00	10.00	2.30	5.29	150.00	10.00	2.30	5.29
1560.00	10.00	2.30	5.29	484.00	16.25	2.79	7.78
10300.00	10.00	2.30	5.29	163.00	10.00	2.30	5.29
210.00	10.00	2.30	5.29	182.00	10.00	2.30	5.29
1600.00	27.00	3.30	10.89				
204.00	85.00	4.44	19.71				
160.00	10.00	2.30	5.29				
Sum:							
-	-	26.14	72.92	-	-	16.59	39.52
Sample Size:							
10	10	10	-	7	7	7	-
Mean:							
2760	19.2	2.61	-	220	10.89	2.37	-
Standard Deviation:							
3209.6	23.7	.71	-	120.5	2.36	.19	-
Variability Factor:							
-	3.70	-	-	-	1.53	-	-

ANOVA Calculations:

$$SSB = \left[\sum_{i=1}^{k} \left(\frac{T_i{}^2}{n_i} \right) \right] - \left(\frac{\left[\sum_{i=1}^{k} T_i \right]^2}{N} \right)$$

$$SSW = \left[\sum_{i=1}^{k} \sum_{j=1}^{n_i} x^2{}_{i,j} \right] - \sum_{i=1}^{k} \left(\frac{T_i{}^2}{n_i} \right)$$

$$MSB = SSB/(k-1)$$

$$MSW = SSW/(N-k)$$

Example 2 (continued)

$F = MSB/MSW$

where:

k = number of treatment technologies

n_i = number of data points for technology i

N = number of data points for all technologies

T_i = sum of natural log transformed data points for each technology

X_{ij} = the natural log transformed observations (j) for treatment technology (i)

$N_1 = 10,\ N_2 = 7,\ N = 17,\ k = 2,\ T_1 = 26.14,\ T_2 = 16.59,\ T = 42.73,\ T^2 = 1825.85,\ T_1^2 = 683.30,$

$T_2^2 = 275.23$

$$SSB = \left(\frac{683.30}{10} + \frac{275.23}{7}\right) - \frac{1825.85}{17} = 0.25$$

$$SSW = (72.92 + 39.52) - \left(\frac{683.30}{10} + \frac{275.23}{7}\right) = 4.79$$

$MSB = 0.25/1 = 0.25$

$MSW = 4.79/15 = 0.32$

$$F = \frac{0.25}{0.32} = 0.78$$

ANOVA Table

Source	Degrees of freedom	SS	MS	F
Between(B)	1	0.25	0.25	0.78
Within(W)	15	4.79	0.32	

The critical value of the F test at the 0.05 significance level is 4.54. Since the F value is less than the critical value, the means are not significantly different (i.e., they are homogeneous).

Note: All calculations were rounded to two decimal places. Results may differ depending upon the number of decimal places used in each step of the calculations.

Example 3
Chlorobenzene

Activated sludge followed by carbon adsorption				Biological treatment			
Influent ($\mu g/l$)	Effluent ($\mu g/l$)	ln(effluent)	$[\ln(\text{effluent})]^2$	Influent ($\mu g/l$)	Effluent ($\mu g/l$)	ln(effluent)	$\ln[(\text{effluent})]^2$
7200.00	80.00	4.38	19.18	9206.00	1083.00	6.99	48.86
6500.00	70.00	4.25	18.06	16646.00	709.50	6.56	43.03
6075.00	35.00	3.56	12.67	49775.00	460.00	6.13	37.58
3040.00	10.00	2.30	5.29	14731.00	142.00	4.96	24.60
				3159.00	603.00	6.40	40.96
				6756.00	153.00	5.03	25.30
				3040.00	17.00	2.83	8.01
Sum:							
-	-	14.49	55.20	-	-	38.90	228.34
Sample Size:							
4	4	4	-	7	7	7	-
Mean:							
5703	49	3.62	-	14759	452.5	5.56	-
Standard Deviation:							
1835.4	32.24	.95		16311.86	379.04	1.42	-
Variability Factor:							
-	7.00	-	-	-	15.79	-	-

ANOVA Calculations:

$$SSB = \left[\sum_{i=1}^{k} \left(\frac{T_i^2}{n_i} \right) \right] - \left(\frac{\left[\sum_{i=1}^{k} T_i \right]^2}{N} \right)$$

$$SSW = \left[\sum_{i=1}^{k} \sum_{j=1}^{n_i} x^2{}_{i,j} \right] - \sum_{i=1}^{k} \left(\frac{T_i^2}{n_i} \right)$$

$$MSB = SSB/(k-1)$$

$$MSW = SSW/(N-k)$$

$$F = MSB/MSW$$

Example 3 (continued)

where,

k = number of treatment technologies

n_i = number of data points for technology i

N = number of data points for all technologies

T_i = sum of natural log transformed data points for each technology

X_{ij} = the natural log transformed observations (j) for treatment technology (i)

$N_1 = 4,\ N_2 = 7,\ N = 11,\ k = 2,\ T_1 = 14.49,\ T_2 = 38.90,\ T = 53.39,\ T^2 = 2850.49,\ T_1^2 = 209.96$

$T_2^2 = 1513.21$

$$SSB = \left(\frac{209.96}{4} + \frac{1513.21}{7}\right) - \frac{2850.49}{11} = 9.52$$

$$SSW = (55.20 + 228.34) - \left(\frac{209.96}{4} + \frac{1513.21}{7}\right) = 14.88$$

$MSB = 9.52/1 = 9.52$

$MSW = 14.88/9 = 1.65$

$F = 9.52/1.65 = 5.77$

ANOVA Table

Source	Degrees of freedom	SS	MS	F
Between(B)	1	9.53	9.53	5.77
Within(W)	9	14.89	1.65	

The critical value of the F test at the 0.05 significance level is 5.12. Since the F value is larger than the critical value, the means are significantly different (i.e., they are heterogeneous).

Note: All calculations were rounded to two decimal places. Results may differ depending upon the number of decimal places used in each step of the calculations.

A.2. Variability Factor

$$VF = \frac{C_{99}}{Mean}$$

where:

VF = estimate of daily maximum variability factor determined from a sample population of daily data.

C_{99} = Estimate of performance values for which 99 percent of the daily observations will be below. C_{99} is calculated using the following equation: $C_{99} = Exp(y + 2.33\ Sy)$ where y and Sy are the mean and standard deviation, respectively, of the logtransformed data.

Mean = average of the individual performance values.

EPA is establishing this figure as an instantaneous maximum because the Agency believes that on a day-to-day basis the waste should meet the applicable treatment standards. In addition, establishing this requirement makes it easier to check compliance on a single day. The 99th percentile is appropriate because it accounts for almost all process variability.

In several cases, all the results from analysis of the residuals from BDAT treatment are found at concentrations less than the detection limit. In such cases, all the actual concentration values are considered unknown and hence, cannot be used to estimate the variability factor of the analytical results. Below is a description of EPA's approach for calculating the variability factor for such cases with all concentrations below the detection limit.

It has been postulated as a general rule that a lognormal distribution adequately describes the variation among concentrations.

Agency data shows that the treatment residual concentrations are distributed approximately lognormally. Therefore, the lognormal model has been used routinely in the EPA development of numerous regulations in the Effluent Guidelines program and is being used in the BDAT program. The variability factor (VF) was defined as the ratio of the 99th percentile (C_{99}) of the lognormal distribution to its arithmetic mean (Mean).

$$VF = \frac{C_{99}}{\text{Mean}} \tag{1}$$

The relationship between the parameters of the lognormal distribution and the parameters of the normal distribution created by taking the natural logarithms of the lognormally-distributed concentrations can be found in most mathematical statistics texts (see for example: Distribution in Statistics-Volume 1 by Johnson and Kotz, 1970). The mean of the lognormal distribution can be expressed in terms of the mean (μ) and standard deviation (σ) of the normal distribution as follows:

$$C_{99} = \text{Exp}\ (\mu + 2.33\sigma) \tag{2}$$
$$\text{Mean} = \text{Exp}\ (\mu + .5\sigma^2) \tag{3}$$

Substituting (2) and (3) in (1) the variability factor can then be expressed in terms of σ as follows:

$$VF = \text{Exp}\ (2.33\ \sigma - .5\sigma^2) \tag{4}$$

For residuals with concentrations that are not all below the detection limit, the 99^{th} percentile and the mean can be estimated from the actual analytical data and accordingly, the variability factor (VF) can be estimated using equation (1). For residuals with concentrations that are below the detection limit, the above equations can be used in conjunction with the assumptions below to develop a variability factor.

Step 1: The actual concentrations follow a lognormal distribution. The upper limit (UL) is equal to the detection limit. The lower limit (LL) is assumed to be equal to one tenth of the detection limit. This assumption is based on the fact that data from well-designed and well-operated treatment systems generally falls within one order of magnitude.

Step 2: The natural logarithms of the concentrations have a normal distribution with an upper limit equal to ln (UL) and a lower limit equal to ln (LL).

Step 3: The standard deviation (σ) of the normal distribution is approximated by

$$\sigma = [(\ln (UL) - \ln (LL)] / [(2)(2.33)] = [\ln(UL/LL)] / 4.66$$

$$\text{when } LL = (0.1)(UL) \text{ then } \sigma = (\ln 10) / 4.66 = 0.494$$

Step 4: Substitution of the value from Step 3 in equation (4) yields the variability factor, VF.

$$VF = 2.8$$

APPENDIX B

MAJOR CONSTITUENT CALCULATION FOR K016, K018, K019, K020, AND K030

B.1 K016

From Table 2-4, major constituents in K016 are:

	Average* Concentration (ppm)	%
42. Tetrachloroethene	85,750	8.6 (≈9)
110. Hexachlorobenzene	27,050	2.7 (≈3)
111. Hexachlorobutadiene	59,250	5.9 (≈6)
113. Hexachloroethane	30,000	3.0

Other BDAT constituents in K016 are:

	Average* Concentration (ppm)	%
112. Hexachlorocyclopentadiene	6,275	0.63 (≈1)

Thus, the major constituents list for K016 is:

Constituent	%
42. Tetrachoroethene	9
110. Hexachlorobenzene	3
111. Hexachlorobutadiene	6
113. Hexachloroethane	3
Other BDAT Constituents	1
Other Constituents	78
	100%

---

*Average concentrations were calculated by averaging available data from all sources. Where a concentration value was reported as less than a detection limit, the detection limit was used in the calculation. Where concentrations were reported as a range of values, the average over the range was used and then averaged with other data.

B.2 K018

From Table 2-5, major constituents in K018 are:

	Average* Concentration (ppm)	%
12. Chloroethane	131,000	13.1 (=13)
22. 1,1-Dichloroethane	356,800	35.6 (=36)
23. 1,2-Dichloroethane	50,000	5.0 (=5)
46. 1,1,2-Trichloroethane	11,600	1.2 (=1)

Other BDAT constituents in K018 are:

	Average* Concentration (ppm)
15. Chloromethane	8,300
45. 1,1,1-Trichloroethane	3,325
110. Hexachlorobenzene	385
111. Hexachlorobutadiene	386
113. Hexachloroethane	381
137. Pentachlorethane	528
	13,305 ppm ---> 1.3 (=1.0%)

Thus, the major constituent list for K018 is:

Constituent	%
12. Chloroethane	13
22. 1,1-Dichloroethane	36
23. 1,2-Dichloroethane	5
46. 1,1,2-Trichloroethane	1
Other BDAT Constituents	1
Other Constituents	44
	100%

---

*Average concentrations were calculated by averaging available data from all sources. Where a concentration value was reported as less than a detection limit, the detection limit was used in the calculation. Where concentrations were reported as a range of values, the average over the range was used and then averaged with other data.

B.3 K019

The following major constituent list for K019 is from Reference 10: "Onsite Engineering Report of Treatment Technology Performance and Operation for Rollins Environmental Services (TX) Inc., Deer Park, Texas".

	Constituent	%
23.	1,2-Dichloroethane	10
46.	1,1,2-Trichloroethane	4
	Other BDAT constituents	2
	Other Constituents	82
	Water	2
		100%

B.4 K020

From Table 2-7, major constituents in K020 are:

		Average* Concentration (ppm)	%
23.	1,2-Dichloroethane	**	**
41.	1,1,2,2-Tetrachloroethane	**	**
42.	Tetrachloroethene	**	**
46.	1,1,2-Trichloroethane	**	**

Thus, the major constituent list for K020 is:

	Constituent	%
23.	1,2-Dichloroethane	**
41.	1,1,2,2-Tetrachloroethane	**
46.	1,1,2-Trichloroethane	**
42.	Tetrachloroethene	**
	Other Constituents	**
		100%

* Average concentrations were calculated by averaging available data from all sources. Where a concentration value was reported as less than a detection limit, the detection limit was used in the calculation. Where concentrations were reported as a range of values, the average over the range was used and then averaged with other data.

** This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

B.5 K030

From Table 2-8, major constituents in K030 are:

	Average* Concentration (ppm)	%
42. Tetrachloroethene	**	**
111. Hexachlorobutadiene	**	**
137. Pentachloroethane	**	**

Other BDAT Constituents in K030 are:

	Average* Concentration (ppm)		
87. o-Dichlorobenzene	**		
88. p-Dichlorobenzene	**		
112. Hexachlorocyclopentadiene	**		
113. Hexachloroethane	**		
115. Hexachloropropene	**		
136. Pentachlorobenzene	**		
148. 1,2,4,5-Tetrachlorobenzene	**		
150. 1,2,4-Trichlorobenzene	**		
	**	--->	**

Thus, the major constituents list for K030 is:

Constituent	%
42. Tetrachloroethene	**
111. Hexachlorobutadiene	**
137. Pentachloroethane	**
Other BDAT Constituents	**
Other Constituents	**
	100%

---

*Average concentrations were calculated by averaging available data from all sources. Where a concentration value was reported as less than a detection limit, the detection limit was used in the calculation. Where concentrations were reported as a range of values, the average over the range was used and then averaged with other data.

**This information has been claimed as RCRA Confidential Business Information. The information is available in the confidential portion of the Administrative Record for this rulemaking.

APPENDIX C

STRIP CHARTS FOR THE SAMPLING EPISODE AT PLANT A: WASTE FEED RATES, KILN TEMPERATURES, AFTERBURNER TEMPERATURES AND EXCESS OXYGEN CONCENTRATION

Figure C-1: RCRA Blend Feed Rates

Figure C-2: PCB Blend Feed Rate

Figure C-3: Kiln and Afterburner Temperatures

Figure C-4: Hot Duct Oxygen Concentration (%)

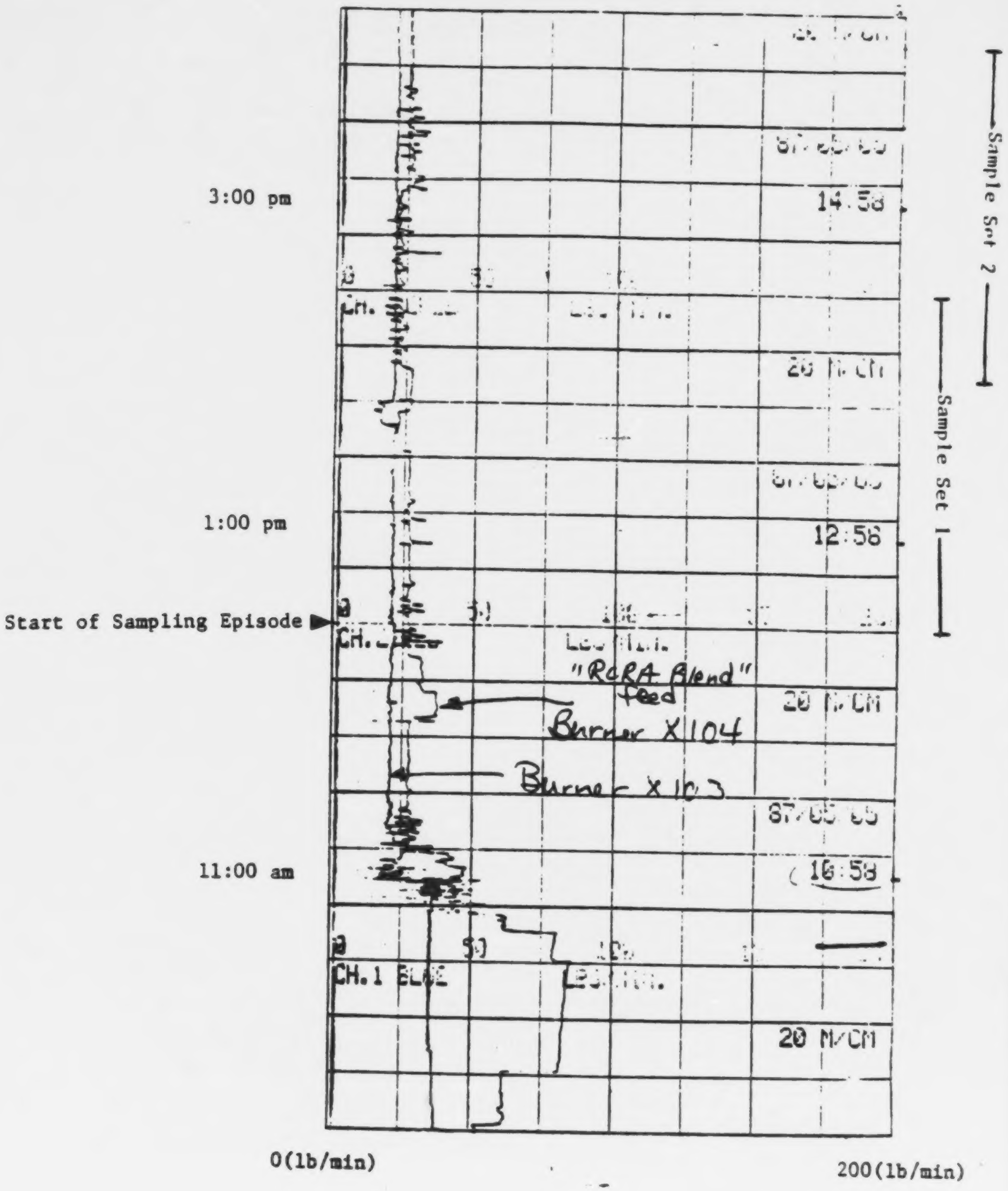


Figure C-1

RCRA BLEND FEED RATES (lb/min)

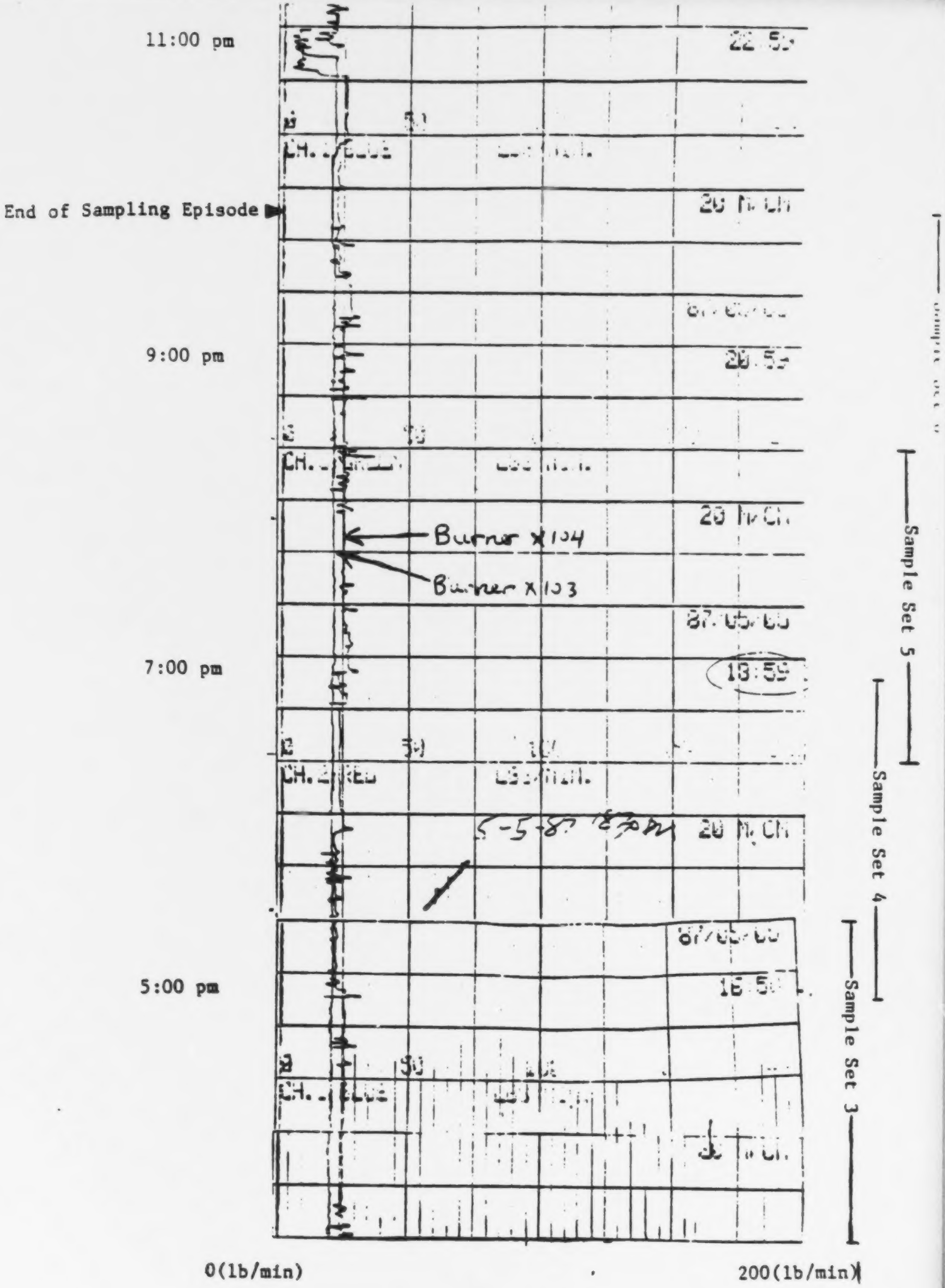
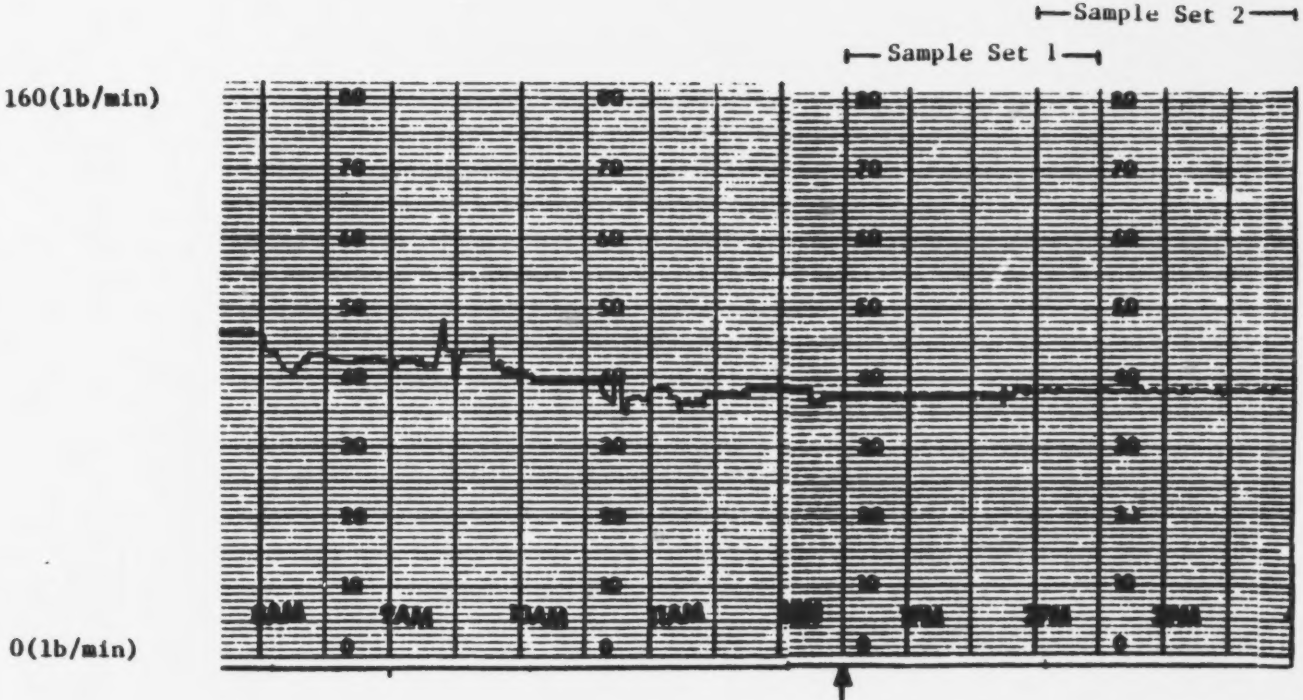


Figure C-1

RCRA BLEND FEED RATES (lb/min)
(Continued)



⊢Sample Set 1⊣

⊢Sample Set 2⊣

Start of Sampling Episode

Figure C-2

PCB BLEND FEED RATE (lb/min)

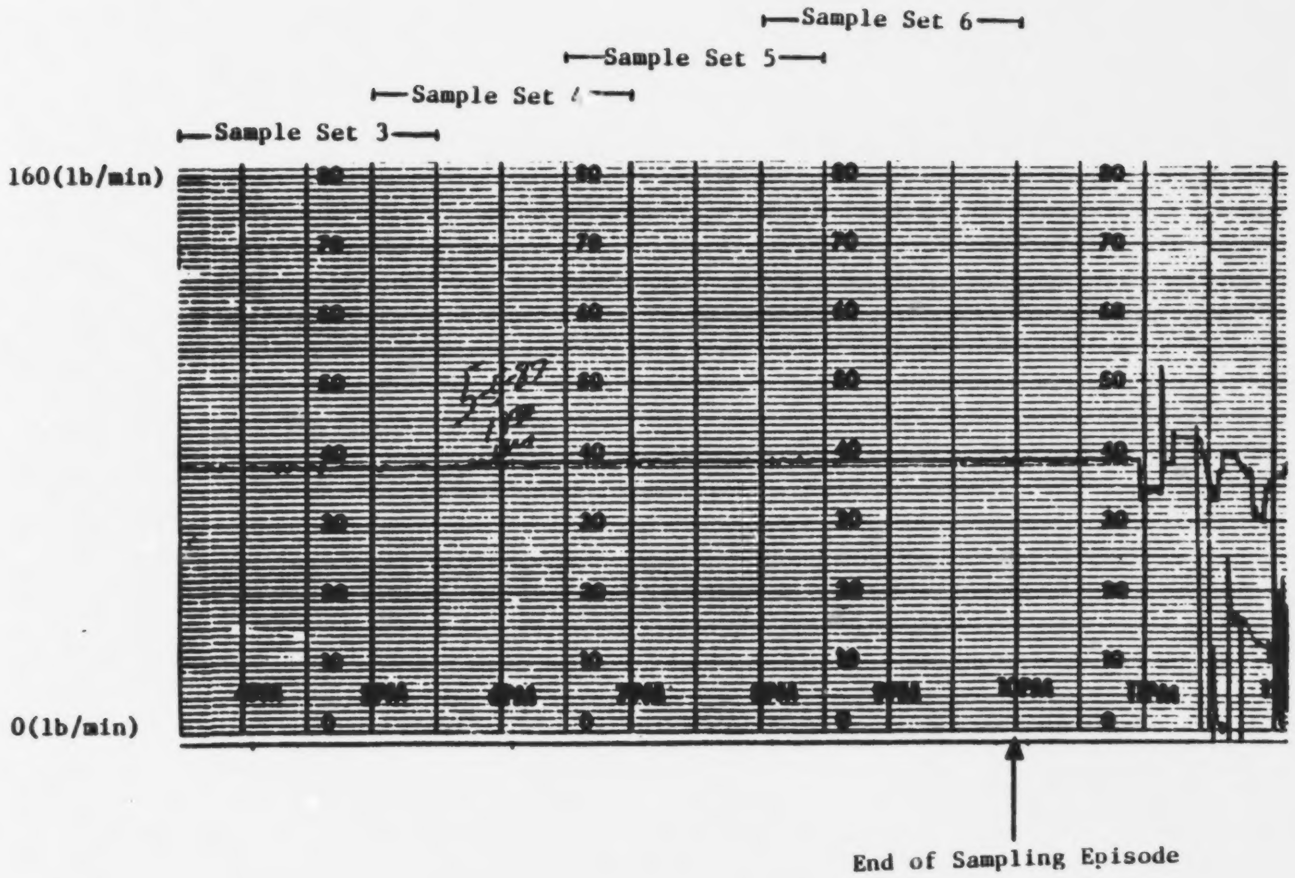


Figure C-2

PCB BLEND FEED RATE (lb/min)
(Continued)

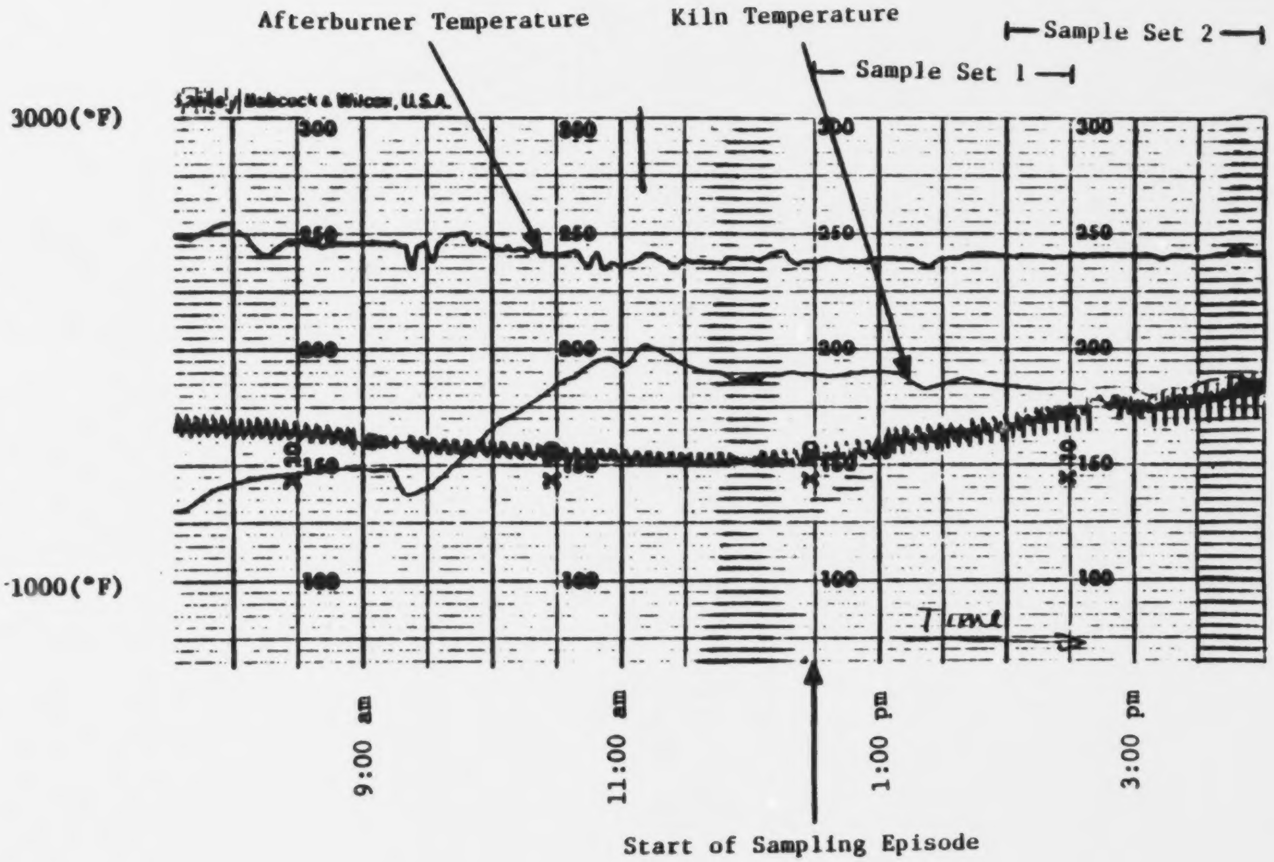


Figure C-3

KILN AND AFTERBURNER TEMPERATURES (°F)

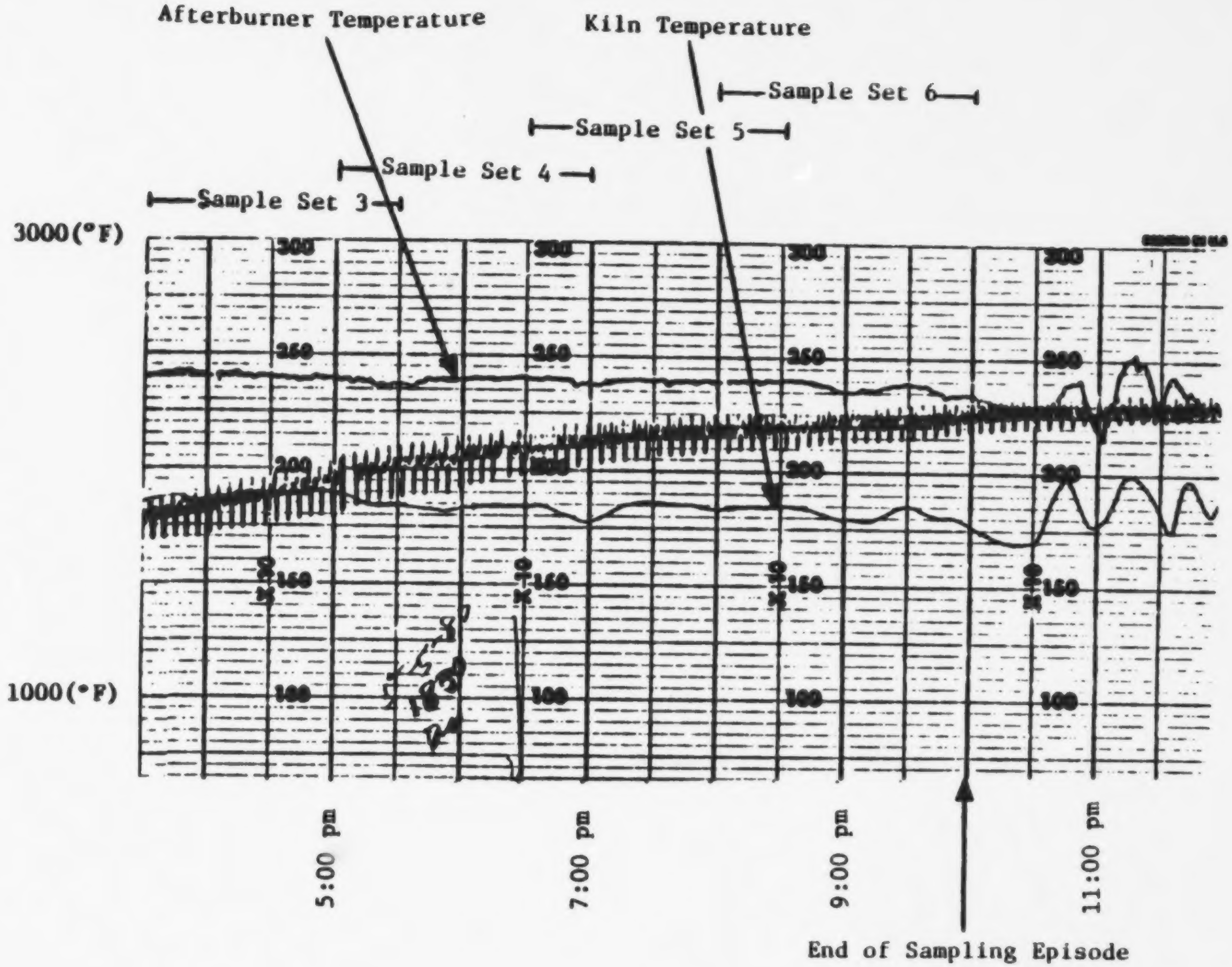


Figure C-3

KILN AND AFTERBURNER TEMPERATURES (°F)
(Continued)

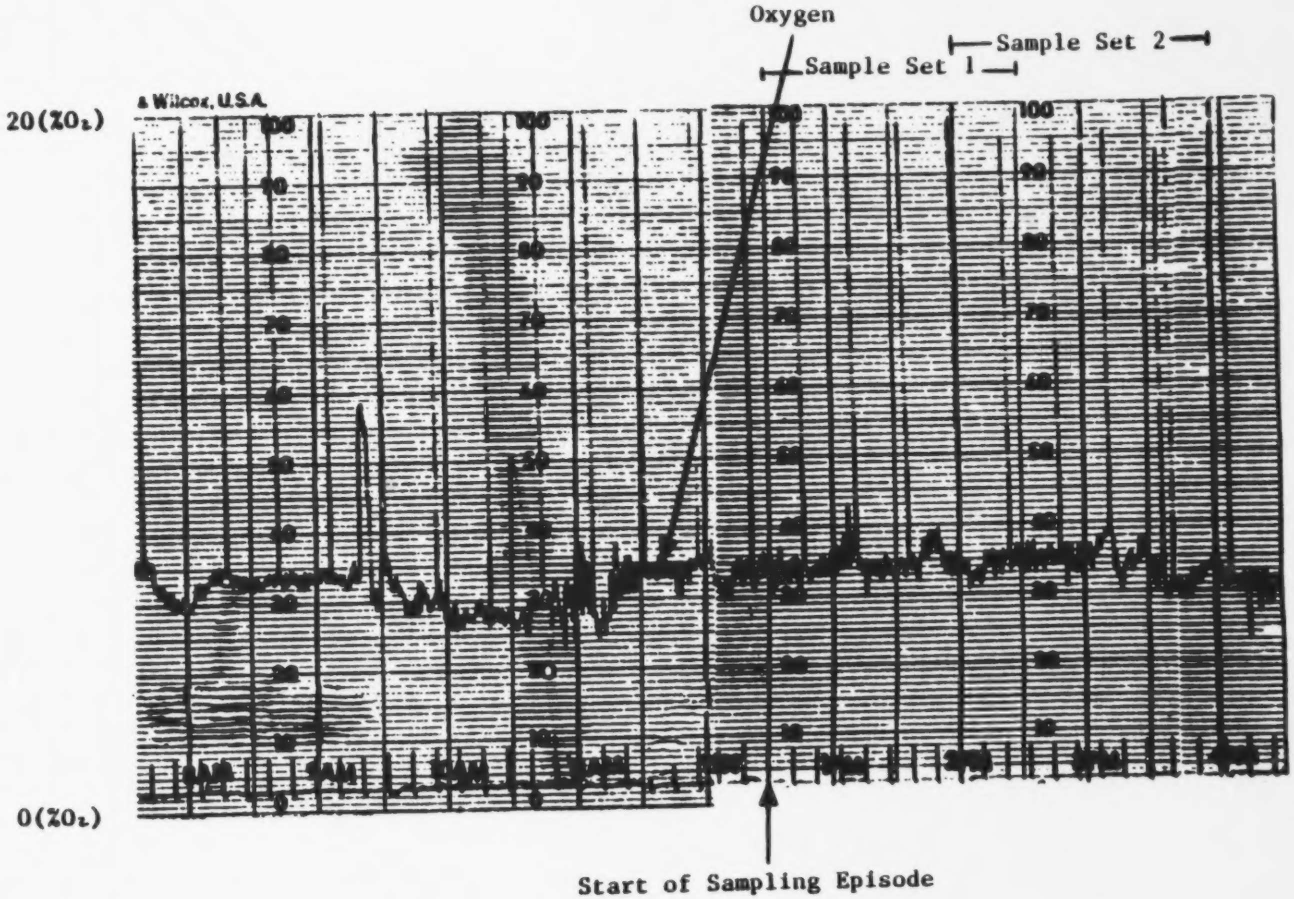


Figure C-4

HOT DUCT OXYGEN CONCENTRATION (%)

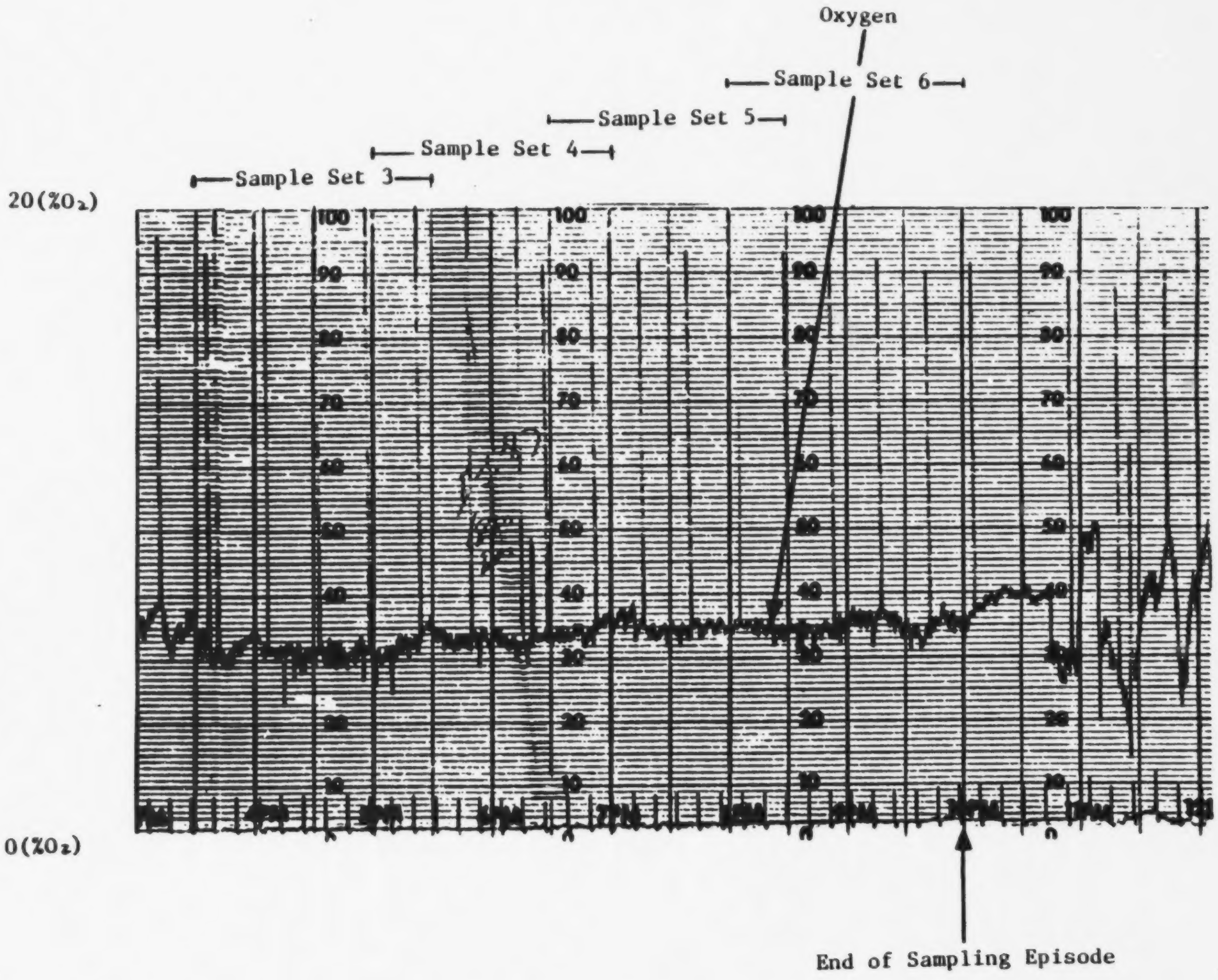


Figure C-4

HOT DUCT OXYGEN CONCENTRATION (%)
(Continued)

APPENDIX D

ANALYTICAL QA/QC

The analytical methods used for analysis of the regulated constituents identified in Section 5.0 are presented in this Appendix. SW-846 methods (EPA's Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846) are used in most cases for determining total constituent concentration.

In some instances it was necessary to deviate from the SW-846 methods. Deviations from SW-846 methods required to analyze the sample matrix are listed in Table D-2. SW-846 allows for the use of alternative or equivalent procedures or equipment; these are noted in Table D-3. These alternatives or equivalents included alternative GC/MS operating conditions, equivalent base/neutral surrogates, and different extraction techniques to reduce sample matrix interferences.

The accuracy determination for a constituent is based on the matrix spike recovery values. Tables D-4 and D-5 present the matrix spike recovery data for volatile and semivolatile constituents in the kiln ash and scrubber water residuals.

The accuracy correction factors for volatile and semivolatile constituents detected in untreated K019 and in the kiln ash and scrubber water residuals are summarized in Table D-6. The accuracy correction factors were determined for each constituent by dividing 100 by the matrix spike recovery (in percent) for that constituent.

Table D-1

ANALYTICAL METHODS FOR REGULATED CONSTITUENTS

Nonwastewater

	Kiln Ash Residue Total Constituent Concentration			Combustion Gas Scrubber Discharge Water Total Constituent Concentration		
Regulated Constituent	Preparation Method	Analytical Method	Reference	Preparation Method	Analytical Method	Reference
Volatile						
9. Chlorobenzene	Purge and Trap (Method 5030)	Gas Chromatography/ Mass Spectrometry for Volatile Organics (Method 8240)	*	Purge and Trap (Method 5030)	Gas Chromatography/ Mass Spectrometry for Volatile Organics (Method 8240)	*
14. Chloroform						
23. 1,2-Dichloroethane						
42. Tetrachloroethene						
45. 1,1,1-Trichloroethane						
Semivolatile						
68. Bis(2-chloroethyl)ether	Sonication Extraction* (Method 3550)	Gas Chromatography/ Mass Spectrometry for Semivolatile Organics: Capillary Column Technique (Method 8270)	*	Separatory Funnel Liquid-Liquid Extraction (Method 3510)	Gas Chromatography/ Mass Spectrometry for Semivolatile Organics Capillary Column Technique (Method 8070)	*
113. Hexachloroethane						
121. Naphthalene						
141. Phenanthrene						
150. 1,2,4-Trichlorobenzene						

Reference:

*Environmental Protection Agency, 1986, Test Methods for Evaluating Solid Waste, Third Edition, U.S. EPA, Office of Solid Waste and Emergency Response, November 1986.

Table D-1 (Continued)

ANALYTICAL METHODS FOR REGULATED CONSTITUENTS

Wastewater	Kiln Ash Residue Total Constituent Concentration			Combustion Gas Scrubber Constituent Concentration		
Regulated Constituent	Preparation Method	Analytical Method	Reference	Preparation Method	Analytical Method	Reference
Volatile						
7. Carbon Tetrachloride	Purge and Trap (Method 5030)	Gas Chromatography/ Mass Spectrometry for Volatile Organics (Method 8240)	*	Purge and Trap (Method 5030)	Gas Chromatography/ Mass Spectrometry for Volatile Organics (Method 8240)	*
14. Chloroform						
23. 1,2-Dichloroethane						
42. Tetrachloroethene						
46. 1,1,2-Trichloroethane						
Semivolatile						
68. Bis(2-chloroethyl)ether	Sonication Extraction* (Method 3550)	Gas Chromatography/ Mass Spectrometry for Semivolatile Organics: Capillary Column Technique (Method 8270)	*	Separatory Funnel Liquid-Liquid Extraction (Method	Gas Chromatography/ Mass Spectrometry for Semivolatile Organics Capillary Column Technique (Method 8070) 3510)	*
88. p-Dichlorobenzene						
110. Hexachlorobenzene						
113. Hexachloroethane						
121. Naphthalene						
136. Pentachlorobenzene						
148. 1,2,4,5-Tetrachlorobenzene						
150. 1,2,4-Trichlorobenzene						

Reference:

*Environmental Protection Agency, 1986, Test Methods for Evaluating Solid Waste, Third Edition, U.S. EPA, Office of Solid Waste and Emergency Response, November 1986.

Table D-2 Deviations from SW-846

Analysis	Method	SW-846 Specification	Deviation from SW-846 Method	Rationale for Deviation
Continuous Liquid/ Liquid Extraction or Soxhlet Extraction or Separatory Funnel Liquid/Liquid Extraction or Sonication	3520 3540 3510 3550	Add 1.0 ml of solution containing 100 ug/ml of the acid surrogates and 200 ug/ml of the base/neutral surrogates. Additional amounts of the surrogates if high concentration samples are expected.	0.1 ml of a solution containing 1,000 ug/ml of the acid surrogates and 2,000 ug/ml of the base/neutral surrogates were added to the samples. The final concentration of the surrogates in the extracts is the same as specified in SW-846.	
		Use a micro Snyder column to adjust the concentrate volumes.	Nitrogen was used to adjust the concentrate volumes for these samples due to the high organic content of the samples.	The use of nitrogen reduced potential sample loss due to bumping that could occur during the concentration of the extracts of these samples.
Continuous Liquid/ Liquid Extraction	3520	Method calls for use 10 N NaOH and 1:1 N H_2SO_4.	More concentrated acid and base solutions were used for buffered samples (e.g., 2:1 H_2SO_4) and 12 N NaOH).	Buffered samples require the addition of large amounts of liquids to accomplish pH changes. Using more concentrated acid and base solutions reduces the amount of acid or base needed and avoids overfilling the extractor with aqueous phase.
Sonication Extraction	3550	SW-846 specifies 3 minutes of sonication.	Sonication is performed for five minutes.	The extended sonification ensures the thorough mixing of these samples.
		No acidification step is required.	The base/neutral extracted kiln ash residue is acidified with 1 ml of 1:1 H_2SO_4, dried with Na_2SO_4 (10 g), and reextracted. The extracts will be combined.	This acidification step yields better recoveries of the acid extractables.
		Either decant extracts and filter through No. 41 paper by vacuum or centrifuge and decant.	Vacuum filtration is not used. Decanting is usually done without centrifugation.	This technique reduces sample transfer steps when samples can be decanted without centrifugation.

Table D-2 (Cont.)

Analysis	Method	SW-846 Specification	Deviation from SW-846 Method	Rationale for Deviation
Gas Chromatography/ Mass Spectrometry for Semivolatile Organics: Capillary Column Technique	8270	The internal standards recommended are 1,4-dichlorobenzene-d_4, napthalene-d_8, acenaphthene-d_{10}, phenanthrene-d_{10}, chrysene-d_{12}, and perylene-d_{12}. Other compounds may be used as internal standards as long as the requirements given in Paragraph 7.3.2 of the method are met. Each compound is dissolved with a small volume of carbon disulfide and diluted to volume with methylene chloride so that the final solvent is approximately 20% carbon disulfide. Most of the compunds are also soluble in small volumes of methanol, acetone, or toluene, except for perylene-d_{12}. The resulting solution will contain each standard at a concentration of 4,000 ng/uL. Each 1-mL sample extract undergoing analysis should be spiked with 10 uL of the internal standard solution, resulting in a concentration of 40 ng/uL of each internal standard.	The preparation of the internal standards was changed to eliminate carbon disulfide as a solvent. The internal standard concentration was changed to 50 ng/ul instead of 40 ng/ul. The standards were dissolved in methylene chloride only. Perylene-d_{12} dissolved in methylene chloride sufficiently to yield reliable results.	
Separatory Funnel Liquid/Liquid Extraction	3510	Extract sample at high pH and then at low pH.	The combustion gas effluent water residue is extracted at low pH first and then at high pH.	
Sulfides	9030	No sample preparation given in Method 9030 for solid waste matrix.	Sample preparation required due to matrix of samples. Distillation of sulfide from the acid solution was used with the sorption of H_2S in NaOH. This method is described in EPA's "Test Method to Determine Hydrogen Sulfide Released from Wastes."	Distillation procedure used to liberate sulfide from various matrices and to reduce potential interferences. SW-846 Method 9030 is applicable only for water samples (drinking, surface, and saline wastes), therefore sample preparation required for other matrices.

Table D-3 Specific Procedures or Equipment Used in Extraction of Organic Compounds When Alternatives or Equivalents are Allowed in the SW-846 Methods

Analysis	SW 846 Method	Sample Aliquot	Alternatives or Equivalents Allowed by SW-846 Methods	Specific Procedures or Equipment Used
Purge and Trap	5030	5 milliliters of liquid or 2 grams of solid	• The purge and trap device to be used is specified in the method in Figure 1, the desorber to be used is described in Figures 2 and 3, and the packing materials are described in Section 4.10.2. The method allows equivalents of this equipment or materials to be used.	• The purge and trap equipment, the desorber, and the packing materials used were as specified in SW-846.
			• The method specifies that the trap must be at least 25 cm long and have an inside diameter of at least 0.105 in.	• The length of the trap was 30 cm and the diameter was 0.25 cm.
			• The surrogates recommended are toluene-d8,4-bromofluorobenzene, and 1,2-dichloroethane-d4. The recommended concentration level is 0.25 ug/ml.	• All 3 surrogates were added at the concentration recommended in SW-846.
Continuous Liquid-Liquid Extraction	3520	1 liter of liquid	• Acid and base/neutral extracts are usually combined before analysis by GC/MS. However, under some situations, they may be extracted and analyzed separately.	• Acid and base/neutral extracts were combined with the exception of the sample collected from the filtration dewatering of DAF float mixture.

Table D-3 (Cont.)

Analysis	SW-846 Method	Sample Aliquot	Alternatives or Equivalents Allowed by SW-846 Methods	Specific Procedures or Equipment Used
Continuous Liquid-Liquid Extraction (continued)			• The base/neutral surrogates recommended are 2-fluorobiphenyl, nitrobenzene-d5, terphenyl-d14. The acid surrogates recommended are 2-fluorophenol, 2,4,6-tribromophenol, and phenol-d6. Additional compounds may be used for surrogates. The recommended concentrations for low-medium concentration level samples are 100 ug/ml for acid surrogates and 200 ug/ml for base/neutral surrogates. Volume of surrogates added may be adjusted	• Surrogates were the same as those recommended by SW-846 with the exception that phenol-d5 was substituted for phenol-d6. The concentrations of surrogates in the samples were 100 ug/ml of acid surrogates and 200 ug/ml of base/neutral surrogates.
Soxhlet Extraction	3540	10 grams of solid	• The recommended surrogates and their concentration levels are the same as for Method 3520.	• The surrogates used and their concentration levels were the same as for Method 3520.
			• Sample grinding may be required for samples not passing through a 1 mm standard sieve or a 1 mm opening.	• Sample grinding was not required.

Table D-3 (Cont.)

Analysis	SW-846 Method	Sample Preparation Method	Alternatives or Equivalents Allowed in SW-846 for Equipment or in Procedure	Specific Equipment or Procedures Used
			• Recommended GC/MS operating conditions:	• Actual GC/MS operating conditions:
Gas Chromatography/ Mass Spectrometry for volatile organics	8240	5030	Electron energy: 70 vols (nominal) Mass range: 35-260 amu Scan time: To give 5 scans/peak but not to exceed 7 sec/scan Initial column temperature: 45°C Initial column holding time: 3 min Column temperature program: 8°C/min Final column temperature: 200°C Final column holding time: 15 min Injector temperature: 200-225°C Source temperature: According to manufacturer's specification Transfer line temperature: 250-300°C Carrier gas: Hydrogen at 50 cm/sec or helium at 30 cm/sec	Electron energy: 70 ev Mass range: 35 - 350 amu Scan time: 2 sec/scan Initial column temperature: 10 C Initial column holding time: 5 min Column temperature program: 6 C/min Final column temperature: 160 C Final column holding time: 20 min Injector temperature: 220 C Source temperature: 250°C Transfer line temperature: 275 C Carrier gas: Helium @ 30 ml/min • Additional Information on Actual System Used Equipment: Finnegan Mat model 5100 GC/MS/DS system Data system: SUPERINCOS^R Mode: Electron impact NBS library available Interface to MS - Jet separator
			• The column should be 6-ft x 0.1 in I.D. glass, packed with 1% SP-1000 on Cartopack B (60/80 mesh) or an equivalent.	• The column used was a capillary VOCOL which is 60 meters long and has an inner diameter of 0.75 mm and a 1.5 µmd$_f$
			Samples may be analyzed be purge and trap technique or by direct injection	• All samples were analyzed using the purge and trap technique

Table D-3 (Cont.)

Analysis	SW-846 Method	Sample Preparation Method	Alternatives or Equivalents Allowed in SW-846 for Equipment or in Procedure	Specific Equipment or Procedures Used
Gas Chromatography/ Mass Spectrometry for semivolatile organics: capillary column technique	8270	3520-Liquids 3540-Solids	• Recommended GC/MS operating conditions: Mass range: 35-500 amu Scan time: 1 sec/scan Initial column temperature: 40°C Initial column holding time: 4 min Column temperature program: 40-270°C at 10°C/min Final column temperature hold: 270°C. (until benzo[g,h,i,]perylene has eluted) Injector temperature: 250-300°C Transfer line temperature: 250-300°C Source temperature: According to manufacturer's specification Injector: Grob-type, splitless Sample volume: 1-2 uL Carrier gas: Hydrogen at 50 cm/sec or helium at 30 cm/sec • The column should be 30 m by 0.25 mm I.D., 1-um film thickness silicon-coated fused silica capillary column (J&W Scientific DB-5 or equivalent).	• Actual GC/MS operating conditions: Mass range: 35 - 450 amu Scan time: 0.5 sec/scan Initial column temperature: 35°C Initial column holding time: 3.5 min Column temperature program: 35°C at 10°C/min Final column temperature hold: 275°C Injector temperature: 275°C Transfer line temperature: 275°C Source temperature: 250°C Injector: Cool-on-column at 35°C Sample volume: 1 uL of sample extract Carrier gas: Hydrogen @ 50 ml/min • Additional Information on Actual System Used: Equipment: Hewelett Packard 5967A GC/MS (Operators Manual Revision B) Software Package: AQUARIUS NBS library available • The column used was the J&W scientific DB-5 silica capillary column. It is 60 meters with a 0.32 mm capillary column inner diameter and a 1.0 um film

Table D-4

MATRIX SPIKE RECOVERIES FOR KILN ASH RESIDUE

Spike Constituent	Original Amount Found (ppb)	Sample Result			Duplicate Sample Result		
		Amount Spiked (ppb)	Amount Recovered (ppb)	Percent* Recovery (%)	Amount Spiked (ppb)	Amount Recovered (ppb)	Percent* Recovery %
VOLATILES							
4. Benzene	<2	25	22.6	90	25	21.2	85
7. Carbon Tetrachloride	**						
9. Chlorobenzene	<2	25	24.8	99	25	25	100
14. Chloroform	**						
22. 1,1-Dichloroethane	**						
23. 1,2-Dichloroethane	**						
24. 1,1-Dichloroethylene	<2	25	21.2	85	25	19.4	78
42. Tetrachloroethene	**						
43. Toluene	**						
45. 1,1,1-Trichloroethane	**						

*Percent recovery = 100 x $(C_i - C_o)/C_t$, where C_i = amount recovered, C_o = original amount found, and C_t = amount spiked.

**No matrix spike was performed for this constituent. The percent recovery for this constituent is based on the lower average percent recovery of the volatile constituents. The lower average percent recovery is 94% from the duplicate sample result.

Table D-4 (Continued)

MATRIX SPIKE RECOVERIES FOR KILN ASH RESIDUE

Spike Constituent	Original Amount Found (ppb)	Sample Result Amount Spiked (ppb)	Sample Result Amount Recovered (ppb)	Sample Result Percent* Recovery (%)	Duplicate Sample Result Amount Spiked (ppb)	Duplicate Sample Result Amount Recovered (ppb)	Duplicate Sample Result Percent* Recovery %
VOLATILES (Continued)							
47. Trichloroethene	<2	25	26.8	107	25	28	112
AVERAGE RECOVERY FOR VOLATILES				95			94
SEMIVOLATILES (BASE/NEUTRAL FRACTION)							
52. Acenaphthene	<2	50	55	110	50	55	110
68. Bis(2-chloroethyl)ether	+						
70. Bis(2-ethylhexyl) phthalate	+						
88. 1,4-Dichlorobenzene	<2	50	45	90	50	49.5	99
98. Di-n-butylphthalate	+						
102. 2,4-Dinitrotoluene	<50	50	53.5	107	50	55	110
105. N-Nitroso-di-n-propylamine	<5	50	60	120	50	65	130

*Percent recovery = 100 x $(C_i - C_o)/C_t$, where C_i = amount recovered, C_o = original amount found, and C_t = amount spiked.

**No matrix spike was performed for this constituent. The percent recovery for this constituent is based on the lower average percent recovery of the volatile constituents. The lower average percent recovery is 94% from the duplicate sample result.

+No matrix spike was performed for this constituent. The percent recovery for this constituent is based on the lower average percent recovery of the semivolatile (base/neutral) constituents. The lower average percent recovery is 103% from the duplicate sample result.

Table D-4 (Continued)

MATRIX SPIKE RECOVERIES FOR KILN ASH RESIDUE

Spike Constituent	Original Amount Found (ppb)	Sample Result Amount Spiked (ppb)	Sample Result Amount Recovered (ppb)	Sample Result Percent* Recovery (%)	Duplicate Sample Result Amount Spiked (ppb)	Duplicate Sample Result Amount Recovered (ppb)	Duplicate Sample Result Percent* Recovery %
SEMIVOLATILES (Continued)							
109. Fluorene	+						
110. Hexachlorobenzene	+						
113. Hexachloroethane	+						
121. Naphthalene	+						
136. Pentachlorobenzene	+						
141. Phenanthrene	+						
145. Pyrene	<2	50	60	120	50	46	92
148. 1,2,4,5-Tetrachlorobenzene	+						
150. 1,2,4-Trichlorobenzene	<5	50	37.5	75	50	40	80
AVERAGE RECOVERY FOR SEMIVOLATILES (BASE/NEUTRAL)				104			103

*Percent recovery = 100 x $(C_i - C_o)/C_t$, where C_i = amount recovered, C_o = original amount found, and C_t = amount spiked.

**No matrix spike was performed for this constituent. The percent recovery for this constituent is based on the lower average percent recovery of the volatile constituents. The lower average percent recovery is 94% from the duplicate sample result.

+No matrix spike was performed for this constituent. The percent recovery for this constituent is based on the lower average percent recovery of the semivolatile (base/neutral) constituents. The lower average percent recovery is 103% from the duplicate sample result.

Table D-5

MATRIX SPIKE RECOVERIES FOR COMBUSTION GAS SCRUBBER DISCHARGE WATER

		Sample Result			Duplicate Sample Result		
Spike Constituent	Original Amount Found (ppb)	Amount Spiked (ppb)	Amount Recovered (ppb)	Percent* Recovery (%)	Amount Spiked (ppb)	Amount Recovered (ppb)	Percent* Recovery %
VOLATILES							
4. Benzene	<2	25	21	84	25	17	68
7. Carbon Tetrachloride	**						
9. Chlorobenzene	<2	25	29	116	25	23	92
14. Chloroform	**						
21. Dichlorodifluoromethane	**						
22. 1,1-Dichloroethane	**						
23. 1,2-Dichloroethane	**						
24. 1,1-Dichloroethylene	<2	25	12	48	25	11	44
42. Tetrachloroethene	**						
43. Toluene	**						

*Percent recovery = 100 x $(C_i - C_o)/C_t$, where C_i = amount recovered, C_o = original amount found, and C_t = amount spiked.

**No matrix spike was performed for this constituent. The percent recovery determined for this constituent to be considered for the final rule is based on the lower average percent recovery of the volatile constituents. The lower average percent recovery is 78% from the duplicate sample result.

+No matrix spike was performed for this constituent. The percent recovery determined for this constituent to be considered for the final rule is based on the lower average percent recovery of the semivolatile (base/neutral) constituents. The lower average percent recovery is 84% from both sample results.

Table D-5 (Continued)

MATRIX SPIKE RECOVERIES FOR COMBUSTION GAS SCRUBBER DISCHARGE WATER

Spike Constituent	Original Amount Found (ppb)	Sample Result Amount Spiked (ppb)	Sample Result Amount Recovered (ppb)	Sample Result Percent* Recovery (%)	Duplicate Sample Result Amount Spiked (ppb)	Duplicate Sample Result Amount Recovered (ppb)	Duplicate Sample Result Percent* Recovery %
VOLATILES (Continued)							
45. 1,1,1-Trichloroethane	**						
47. Trichloroethene	<2	25	21	84	25	27	108
AVERAGE PERCENT RECOVERY FOR VOLATILE				83			78
SEMIVOLATILES (Base/Neutral Fraction)							
52. Acenaphthene	<5	50	51	102	50	51	102
68. Bis(2-chloroethyl)ether	+						
88. 1,4-Dichlorobenzene	<2	50	34	68	50	35	70
98. Di-n-butylphthalate	+						
102. 2,4-Dinitrotoluene	<2	50	43	86	50	42	84
105. N-Nitroso-di-n-propylamine	<5	50	50	100	50	46	92

*Percent recovery = 100 x $(C_i - C_o)/C_t$, where C_i = amount recovered, C_o = original amount found, and C_t = amount spiked.

**No matrix spike was performed for this constituent. The percent recovery determined for this constituent to be considered for the final rule is based on the lower average percent recovery of the volatile constituents. The lower average percent recovery is 78% from the duplicate sample result.

+No matrix spike was performed for this constituent. The percent recovery determined for this constituent to be considered for the final rule is based on the lower average percent recovery of the semivolatile (base/neutral) constituents. The lower average percent recovery is 84% from both sample results.

Table D-5 (Continued)

MATRIX SPIKE RECOVERIES FOR COMBUSTION GAS SCRUBBER DISCHARGE WATER

Spike Constituent	Original Amount Found (ppb)	Sample Result			Duplicate Sample Result		
		Amount Spiked (ppb)	Amount Recovered (ppb)	Percent* Recovery (%)	Amount Spiked (ppb)	Amount Recovered (ppb)	Percent* Recovery %
SEMIVOLATILES (Continued)							
109. Fluorene	+						
110. Hexachlorobenzene	+						
113. Hexachloroethane	+						
121. Naphthalene	+						
136. Pentachlorobenzene	+						
141. Phenanthrene	+						
145. Pyrene	<2	50	43	86	50	43	86
148. 1,2,4,5-Tetrachlorobenzene	+						
150. 1,2,4-Trichlorobenzene	<10	50	30	60	50	34	68
AVERAGE PERCENT RECOVERY FOR SEMIVOLATILES (BASE/NEUTRALS)				84			84

*Percent recovery = 100 x $(C_i - C_o)/C_t$, where C_i = amount recovered, C_o = original amount found, and C_t = amount spiked.

**No matrix spike was performed for this constituent. The percent recovery determined for this constituent to be considered for the final rule is based on the lower average percent recovery of the volatile constituents. The lower average percent recovery is 78% from the duplicate sample result.

+No matrix spike was performed for this constituent. The percent recovery determined for this constituent to be considered for the final rule is based on the lower average percent recovery of the semivolatile (base/neutral) constituents. The lower average percent recovery is 84% from both sample results.

Table D-6

SUMMARY OF ACCURACY CORRECTION FACTORS

Constituent	Accuracy Correction Factor*	
	Kiln Ash Residue Total Composition	Scrubber Water Total Composition
7. Carbon tetrachloride	1.06	1.28
9. Chlorobenzene	1.01	1.09
14. Chloroform	1.06	1.28
21. Dichlorodifluoromethane	--	1.28
22. 1,1-Dichloroethane	1.06	1.28
23. 1,2-Dichloroethane	1.06	1.28
42. Tetrachloroethene	1.06	1.28
43. Toluene	--	1.28
45. 1,1,1-Trichloroethane	1.06	1.28
47. Trichloroethene	0.93	1.19
68. Bis(2-chloroethyl)ether	0.97	1.19
70. Bis(2-ethylhexyl)phthalate	0.97	--
88. p-Dichlorobenzene	1.11	1.47
98. Di-n-butylphthalate	0.97	1.19
109. Fluorene	0.97	1.19
110. Hexachlorobenzene	0.97	1.19
113. Hexachloroethane	0.97	1.19
121. Naphthalene	0.97	1.19
136. Pentachlorobenzene	0.97	1.19
141. Phenanthrene	0.97	1.19
148. 1,2,4,5-Tetrachlorobenzene	0.97	1.10
150. 1,2,4-Trichlorobenzene	1.33	1.67

*The Accuracy Corrrection factor is equal to 1 divided by the Percent Recovery Correction Factor.

Table D-7

Calculation of BDAT Treatment Standards
Waste Code: K019
(Scrubber Water Composition)

This table presents the calculations of the corrected analytical values for constituents which were detected in the untreated or the treated waste, using the accuracy correction factors*(ACF). Note that when a constituent is not detected in the ash the unadjusted analytical value is set equal to the detection limit. The unadjusted analytical values and detection limits are labeled "a" and "dl", respectively.

	Sample Set					
Constituent	1	2	3	4	5	6
7.Carbon tetrachloride						
unadjusted value (mg/l)	0.002	0.002	0.002	0.002	0.002	0.002
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.262	1.262	1.262	1.262	1.262	1.262
adjusted value (mg/l)**	0.003	0.003	0.003	0.003	0.003	0.003
9.Chlorobenzene						
unadjusted value (mg/l)	0.002	0.002	0.002	0.002	0.002	0.002
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.067	1.067	1.067	1.067	1.067	1.067
adjusted value (mg/l)**	0.002	0.002	0.002	0.002	0.002	0.002
14.Chloroform						
unadjusted value (mg/l)	0.002	0.002	0.002	0.002	0.002	0.002
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.262	1.262	1.262	1.262	1.262	1.262
adjusted value (mg/l)**	0.003	0.003	0.003	0.003	0.003	0.003
21.Dichlorodifluoromethane						
unadjusted value (mg/l)	0.002	0.002	0.004	0.014	0.002	0.002
a or dl	dl	dl	a	a	dl	dl
ACF	1.262	1.262	1.262	1.262	1.262	1.262
adjusted value (mg/l)**	0.003	0.003	0.005	0.018	0.003	0.003
22.1,1-Dichloroethane						
unadjusted value (mg/l)	0.002	0.002	0.002	0.002	0.002	0.002
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.262	1.262	1.262	1.262	1.262	1.262
adjusted value (mg/l)**	0.003	0.003	0.003	0.003	0.003	0.003

* Accuracy Correction Factors are presented in Table D-6.

** Adjusted value = (Unadjusted value) x (ACF)

Table D-7 (Continued)

Calculation of BDAT Treatment Standards

Waste Code: K019

(Scrubber Water Composition)

This table presents the calculations of the corrected analytical values for constituents which were detected in the untreated or the treated waste, using the accuracy correction factors*(ACF). Note that when a constituent is not detected in the ash the unadjusted analytical value is set equal to the detection limit. The unadjusted analytical values and detection limits are labeled "a" and "dl", respectively.

Constituent	Sample Set 1	2	3	4	5	6
23.1,2-Dichloroethane						
unadjusted value (mg/l)	0.002	0.002	0.002	0.002	0.002	0.002
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.282	1.282	1.282	1.282	1.282	1.282
adjusted value (mg/l)**	0.003	0.003	0.003	0.003	0.003	0.003
42.Tetrachloroethene						
unadjusted value (mg/l)	0.002	0.002	0.002	0.002	0.002	0.002
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.282	1.282	1.282	1.282	1.282	1.282
adjusted value (mg/l)**	0.003	0.003	0.003	0.003	0.003	0.003
43.Toluene						
unadjusted value (mg/l)	0.002	0.003	0.003	0.006	0.002	0.002
a or dl	dl	a	a	a	dl	dl
ACF	1.282	1.282	1.282	1.282	1.282	1.282
adjusted value (mg/l)**	0.003	0.004	0.003	0.008	0.003	0.003
45.1,1,1-Trichloroethane						
unadjusted value (mg/l)	0.002	0.002	0.002	0.002	0.002	0.002
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.282	1.282	1.282	1.282	1.282	1.282
adjusted value (mg/l)**	0.003	0.003	0.003	0.003	0.003	0.003
47.Trichloroethene						
unadjusted value (mg/l)	0.002	0.002	0.002	0.002	0.002	0.002
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.190	1.190	1.190	1.190	1.190	1.190
adjusted value (mg/l)**	0.002	0.002	0.002	0.002	0.002	0.002

* Accuracy Correction Factors are presented in Table D-6.

** Adjusted value = (Unadjusted value) x (ACF)

Table D-7 (Continued)
Calculation of BDAT Treatment Standards
Waste Code: K019
(Scrubber Water Composition)

This table presents the calculations of the corrected analytical values for constituents which were detected in the untreated or the treated waste, using the accuracy correction factors*(ACF). Note that when a constituent is not detected in the ash the unadjusted analytical value is set equal to the detection limit. The unadjusted analytical values and detection limits are labeled "a" and "dl", respectively.

Constituent	Sample Set 1	2	3	4	5	6
68.Bis(2-chloroethyl)ether						
unadjusted value (mg/l)	0.002	0.002	0.002	0.002	0.002	0.002
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.190	1.190	1.190	1.190	1.190	1.190
adjusted value (mg/l)**	0.002	0.002	0.002	0.002	0.002	0.002
88.p-Dichlorobenzene						
unadjusted value (mg/l)	0.002	0.002	0.002	0.002	0.002	0.002
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.471	1.471	1.471	1.471	1.471	1.471
adjusted value (mg/l)**	0.003	0.003	0.003	0.003	0.003	0.003
98.Di-n-butyl phthalate						
unadjusted value (mg/l)	0.002	0.008	0.005	0.004	0.003	0.003
a or dl	dl	a	a	a	a	a
ACF	1.190	1.190	1.190	1.190	1.190	1.190
adjusted value (mg/l)**	0.002	0.008	0.005	0.005	0.003	0.003
109.Fluorene						
unadjusted value (mg/l)	0.002	0.002	0.002	0.002	0.002	0.002
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.190	1.190	1.190	1.190	1.190	1.190
adjusted value (mg/l)**	0.002	0.002	0.002	0.002	0.002	0.002
110.Hexachlorobenzene						
unadjusted value (mg/l)	0.010	0.010	0.010	0.010	0.010	0.010
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.190	1.190	1.190	1.190	1.190	1.190
adjusted value (mg/l)**	0.012	0.012	0.012	0.012	0.012	0.012

* Accuracy Correction Factors are presented in Table D-8.

** Adjusted value = (Unadjusted value) x (ACF)

Table D-7 (Continued)

Calculation of BDAT Treatment Standards
Waste Code: K019
(Scrubber Water Composition)

This table presents the calculations of the corrected analytical values for constituents which were detected in the untreated or the treated waste, using the accuracy correction factors*(ACF). Note that when a constituent is not detected in the ash the unadjusted analytical value is set equal to the detection limit. The unadjusted analytical values and detection limits are labeled "a" and "dl", respectively.

Constituent	Sample Set 1	2	3	4	5	6
113.Hexachloroethane						
unadjusted value (mg/l)	0.010	0.010	0.010	0.010	0.010	0.010
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.190	1.190	1.190	1.190	1.190	1.190
adjusted value (mg/l)**	0.012	0.012	0.012	0.012	0.012	0.012
121.Naphthalene						
unadjusted value (mg/l)	0.002	0.002	0.002	0.002	0.002	0.002
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.190	1.190	1.190	1.190	1.190	1.190
adjusted value (mg/l)**	0.002	0.002	0.002	0.002	0.002	0.002
136.Pentachlorobenzene						
unadjusted value (mg/l)	0.010	0.010	0.010	0.010	0.010	0.010
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.190	1.190	1.190	1.190	1.190	1.190
adjusted value (mg/l)**	0.012	0.012	0.012	0.012	0.012	0.012
141.Phenanthrene						
unadjusted value (mg/l)	0.002	0.002	0.002	0.002	0.002	0.002
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.190	1.190	1.190	1.190	1.190	1.190
adjusted value (mg/l)**	0.002	0.002	0.002	0.002	0.002	0.002
148.1,2,4,5-Tetrachlorobenzene						
unadjusted value (mg/l)	0.005	0.005	0.005	0.005	0.005	0.005
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.190	1.190	1.190	1.190	1.190	1.190
adjusted value (mg/l)**	0.006	0.006	0.006	0.006	0.006	0.006

* Accuracy Correction Factors are presented in Table D-6.

** Adjusted value = (Unadjusted value) x (ACF)

Table D-7 (Continued)

Calculation of BDAT Treatment Standards
Waste Code: K019
(Scrubber Water Composition)

This table presents the calculations of the corrected analytical values for constituents which were detected in the untreated or the treated waste, using the accuracy correction factors*(ACF). Note that when a constituent is not detected in the ash the unadjusted analytical value is set equal to the detection limit. The unadjusted analytical values and detection limits are labeled "a" and "dl", respectively.

Constituent	Sample Set 1	2	3	4	5	6
150.1,2,4-Trichlorobenzene						
unadjusted value (mg/l)	0.005	0.005	0.005	0.005	0.005	0.005
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.667	1.667	1.667	1.667	1.667	1.667
adjusted value (mg/l)**	0.008	0.008	0.008	0.008	0.008	0.008

* Accuracy Correction Factors are presented in Table D-8.

** Adjusted value = (Unadjusted value) x (ACF)

Table D-8

Calculation of BDAT Treatment Standards
Waste Code: K019
(Rotary Kiln Incinerator Ash Composition)

This table presents the calculations of the corrected analytical values for the regulated constituents using the acurracy correction factors* (ACF). Note that when a constituent is not detected in the ash the unadjusted analytical value is set equal to the detection limit. The unadjusted analytical values and detection limits are labeled "a" and "dl", respectively.

	Sample Set					
Constituent	1	2	3	4	5	6
7. Carbon tetrachloride						
unadjusted value (mg/kg)	2.000	2.000	2.000	2.000	2.000	2.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.064	1.064	1.064	1.064	1.064	1.064
adjusted value (mg/kg)**	2.128	2.128	2.128	2.128	2.128	2.128
9.Chlorobenzene						
unadjusted value (mg/kg)	2.000	2.000	2.000	2.000	2.000	2.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.010	1.010	1.010	1.010	1.010	1.010
adjusted value (mg/kg)**	2.020	2.020	2.020	2.020	2.020	2.020
14.Chloroform						
unadjusted value (mg/kg)	2.000	2.000	2.000	2.000	2.000	2.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.064	1.064	1.064	1.064	1.064	1.064
adjusted value (mg/kg)**	2.128	2.128	2.128	2.128	2.128	2.128
22.1,1-Dichloroethane						
unadjusted value (mg/kg)	2.000	2.000	2.000	2.000	2.000	2.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.064	1.064	1.064	1.064	1.064	1.064
adjusted value (mg/kg)**	2.128	2.128	2.128	2.128	2.128	2.128
23.1,2-Dichloroethane						
unadjusted value (mg/kg)	2.000	2.000	2.000	2.000	2.000	2.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.064	1.064	1.064	1.064	1.064	1.064
adjusted value (mg/kg)**	2.128	2.128	2.128	2.128	2.128	2.128

* Accuracy Correction Factors are presented in the Background Document.

** Adjusted value = (Unadjusted value) x (ACF)

Table D-8(Continued)

Calculation of BDAT Treatment Standards (Continued)
Waste Code: K019
(Rotary Kiln Incinerator Ash Composition)

This table presents the calculations of the corrected analytical values for the regulated constituents using the acurracy correction factors*(ACF). Note that when a constituent is not detected in the ash the unadjusted analytical value is set equal to the detection limit. The unadjusted analytical values and detection limits are labeled a and dl, respectively.

	Sample Set					
Constituent (Cont.)	1	2	3	4	5	6
42.Tetrachloroethane						
unadjusted value (mg/kg)	2.000	2.000	2.000	2.000	2.000	2.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.064	1.064	1.064	1.064	1.064	1.064
adjusted value (mg/kg)**	2.128	2.128	2.128	2.128	2.128	2.128
45.1,1,1-Trichloroethane						
unadjusted value (mg/kg)	2.000	2.000	2.000	2.000	2.000	2.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.064	1.064	1.064	1.064	1.064	1.064
adjusted value (mg/kg)**	2.128	2.128	2.128	2.128	2.128	2.128
47. Trichloroethene						
unadjusted value (mg/kg)	2.000	2.000	2.000	2.000	2.000	2.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.000	1.000	1.000	1.000	1.000	1.000
adjusted value (mg/kg)**	2.000	2.000	2.000	2.000	2.000	2.000
68.Bis(2-chloroethyl)ether						
unadjusted value (mg/kg)	2.000	2.000	2.000	2.000	2.000	2.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.000	1.000	1.000	1.000	1.000	1.000
adjusted value (mg/kg)**	2.000	2.000	2.000	2.000	2.000	2.000
70. Bis(2-ethylhexyl)phthalate						
unadjusted value (mg/kg)	2.000	2.000	2.000	12.000	2.000	2.000
a or dl	dl	dl	dl	a	dl	dl
ACF	1.000	1.000	1.000	1.000	1.000	1.000
adjusted value (mg/kg)**	2.000	2.000	2.000	12.000	2.000	2.000

* Accuracy Correction Factors are presented in the Background Document.

** Adjusted value = (Unadjusted value) x (ACF)

Table D-8(Continued)

Calculation of BDAT Treatment Standards (Continued)
Waste Code: K019
(Rotary Kiln Incinerator Ash Composition)

This table presents the calculations of the corrected analytical values for the regulated constituents using the acurracy correction factors*(ACF). Note that when a constituent is not detected in the ash the unadjusted analytical value is set equal to the detection limit. The unadjusted analytical values and detection limits are labeled a and dl, respectively.

	Sample Set					
Constituent (Cont.)	1	2	3	4	5	6
88. p-Dichlorobenzene						
unadjusted value (mg/kg)	2.000	2.000	2.000	2.000	2.000	2.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.111	1.111	1.111	1.111	1.111	1.111
adjusted value (mg/kg)**	2.222	2.222	2.222	2.222	2.222	2.222
98. Di-n-butyl phthalate						
unadjusted value (mg/kg)	2.000	2.000	2.000	230.000	2.000	2.000
a or dl	dl	dl	dl	a	dl	dl
ACF	1.000	1.000	1.000	1.000	1.000	1.000
adjusted value (mg/kg)**	2.000	2.000	2.000	230.000	2.000	2.000
110. Hexachlorobenzene						
unadjusted value (mg/kg)	10.000	10.000	10.000	10.000	10.000	10.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.000	1.000	1.000	1.000	1.000	1.000
adjusted value (mg/kg)**	10.000	10.000	10.000	10.000	10.000	10.000
113.Hexachloroethane						
unadjusted value (mg/kg)	10.000	10.000	10.000	10.000	10.000	10.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.000	1.000	1.000	1.000	1.000	1.000
adjusted value (mg/kg)**	10.000	10.000	10.000	10.000	10.000	10.000
121.Naphthalene						
unadjusted value (mg/kg)	2.000	2.000	2.000	2.000	2.000	2.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.000	1.000	1.000	1.000	1.000	1.000
adjusted value (mg/kg)**	2.000	2.000	2.000	2.000	2.000	2.000

* Accuracy Correction Factors are presented in the Background Document.

** Adjusted value = (Unadjusted value) x (ACF)

Table D-8(Continued)

Calculation of BDAT Treatment Standards (Continued)

Waste Code: K019

(Rotary Kiln Incinerator Ash Composition)

This table presents the calculations of the corrected analytical values for the regulated constituents using the acurracy correction factors*(ACF). Note that when a constituent is not detected in the ash the unadjusted analytical value is set equal to the detection limit. The unadjusted analytical values and detection limits are labeled a and dl, respectively.

	Sample Set					
Constituent (Cont.)	1	2	3	4	5	6
136.Pentachlorobenzene						
unadjusted value (mg/kg)	10.000	10.000	10.000	10.000	10.000	10.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.000	1.000	1.000	1.000	1.000	1.000
adjusted value (mg/kg)**	10.000	10.000	10.000	10.000	10.000	10.000
141.Phenanthrene						
unadjusted value (mg/kg)	2.000	2.000	2.000	2.000	2.000	2.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.000	1.000	1.000	1.000	1.000	1.000
adjusted value (mg/kg)**	2.000	2.000	2.000	2.000	2.000	2.000
148.1,2,4,5-Tetrachlorobenzene						
unadjusted value (mg/kg)	5.000	5.000	5.000	5.000	5.000	5.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.000	1.000	1.000	1.000	1.000	1.000
adjusted value (mg/kg)**	5.000	5.000	5.000	5.000	5.000	5.000
150.1,2,4-Trichlorobenzene						
unadjusted value (mg/kg)	5.000	5.000	5.000	5.000	5.000	5.000
a or dl	dl	dl	dl	dl	dl	dl
ACF	1.333	1.333	1.333	1.333	1.333	1.333
adjusted value (mg/kg)**	6.667	6.667	6.667	6.667	6.667	6.667

* Accuracy Correction Factors are presented in the Background Document.

** Adjusted value = (Unadjusted value) x (ACF)

Appendix E

WASTE CHARACTERISTICS AFFECTING PERFORMANCE

Page

List of boiling points for constituents of interest. E-1

List of bond dissociation energies for constituents of interest. E-2

APPENDIX E

CONSTITUENT BOILING POINTS

Constituent	Boiling Point (^{o}C)	Reference Number
7. Carbon tetrachloride	76.7-77	1
9. Chlorobenzene	131-132	1
12. Chloroethane	12-12.3	1
14. Chloroform	61-62	1
15. Chloromethane	(-24)-(-23.7)	1
22. 1,1-Dichloroethane	57-57.3	1
23. 1,2-Dichloroethane	83-84	1
226. Ethyl benzene	136.25	1
41. 1,1,2,2-Tetrachloroethane	146.5-147	1
42. Tetrachloroethane	121	1
45. 1,1,1-Trichloroethane	74-74.1	1
46. 1,1,2-Trichloroethane	113-114	1
47. Trichloroethene	86.7-87	1
68. Bis(2-chloroethyl)ether	178	1
70. Bis(2-ethylhexyl)phthalate	385	2
87. o-Dichlorobenzene	180.5-181	1
88. p-Dichlorobenzene	174-174.12	1
98. Di-n-butyl phthalate	340	1
109. Fluorene	295	1
110. Hexachlorobenzene	323-326	1
111. Hexachlorobutadiene	210-220	2
112. Hexachlorocyclopentadiene	234	2
113. Hexachloroethane	186.8-187	1
115. Hexachloropropene	209-210	3
121. Naphthalene	217.9-218	1
136. Pentachlorobenzene	275-277	2
137. Pentachloroethane	161-162	1
141. Phenanthrene	340	1
148. 1,2,4,5-Tetrachlorobenzene	246	2
150. 1,2,4-Trichlorobenzene	213	1

1 = Merck Index (Reference 15).

2 = Handbook of Environmental Data on Organic Chemicals (Reference 16).

3 = Handbook of Chemistry and Physics (Reference 17).

APPENDIX E

BOND DISSOCIATION ENERGIES

	Constituents	Bond Dissociation Energy
7.	Carbon tetrachloride	380
9.	Chlorobenzene	1320
12.	Chloroethane	665
14.	Chloroform	385
15.	Chloromethane	395
22.	1,1-Dichloroethane	675
23.	1,2-Dichloroethane	675
41.	1,1,2,2-Tetrachloroethane	665
42.	Tetrachloroethene	465
45.	1,1,1-Trichloroethane	670
46.	1,1,2-Trichloroethane	670
47.	Trichloroethane	481
68.	Bis(2-chloroethyl)ether	1290
70.	Bis(2-ethylhexyl)phthalate	6565
87.	o-Dichlorobenzene	1330
88.	p-Dichlorobenzene	1330
98.	Di-n-butyl phthalate	4285
109.	Fluorene	2740
110.	Hexachlorobenzene	1310
111.	Hexachlorobutadiene	855
112.	Hexachlorocyclopentadiene	1020
113.	Hexachloroethane	655
115.	Hexachloropropene	710
121.	Naphthalene	2120
136.	Pentachlorobenzene	1320
137.	Pentachloroethane	660
141.	Phenanthrene	2900
148.	1,2,4,5-Tetrachlorobenzene	1320
150.	1,2,4-Trichlorobenzene	1325

Sources:

Sanderson, R.T. Chemical Bonds and Bond Energy (Reference 14).
Langes's Handbook of Chemistry (Reference 12).
Handbook of Chemistry and Physics (Reference 17).

APPENDIX F

DETECTION LIMITS FOR UNTREATED WASTES

TABLE 6-2A: K019 WASTE BDAT LIST CONSTITUENT DETECTION LIMITS (VOLATILES)

BDAT CONSTITUENT		DETECTION LIMIT ** SAMPLE SET #1	DETECTION LIMIT ** SAMPLE SETS #2 THROUGH #6
VOLATILE CONSTITUENTS:		[ppm]	[ppm]
1	Acetonitrile	1000	10000
2	Acrolein	10000	100000
3	Acrylonitrile	1000	10000
4	Benzene	2000	2000
5	Bromodichloromethane	200	2000
6	Bromomethane	200	2000
7	Carbon tetrachloride	2000	2000
8	Carbon disulfide	NA	NA
9	Chlorobenzene	2000	2000
10	2-Chloro-1,3-butadiene	200	2000
11	Chlorodibromomethane	200	2000
12	Chloroethane	200	2000
13	2-Chloroethyl vinyl ether	NA	NA
14	Chloroform	2000	2000
15	Chloromethane	200	2000
16	3-Chloropropene	200	2000
17	1,2-Dibromo-3-chloropropane	200	2000
18	1,2-Dibromoethane	200	2000
19	Dibromomethane	200	2000
20	Trans-1,4-dichloro-2-butene	10000	10000
21	Dichlorodifluoromethane	200	2000
22	1,1-Dichloroethane	2000	2000
23	1,2-Dichloroethane	2000	2000
24	1,1-Dichloroethylene	200	2000
25	Trans-1,2-dichloroethene	200	2000
26	1,2-Dichloropropane	500	5000
27	Trans-1,3-dichloropropene	500	5000
28	cis-1,3-Dichloropropene	500	5000
29	1,4-Dioxane	NA	NA
30	Ethyl cyanide	10000	100000
31	Ethyl methacrylate	200	2000
32	Iodomethane	200	2000
33	Isobutyl alcohol	200	2000
34	Methyl ethyl ketone	1000	10000
35	Methyl methacrylate	200	2000
37	Methylacrylonitrile	1000	10000
38	Methylene chloride	1000	10000
40	1,1,1,2-Tetrachloroethane	200	2000
41	1,1,2,2-Tetrachloroethane	2000	2000
42	Tetrachloroethene	2000	2000
43	Toluene	200	2000
44	Tribromomethane	200	2000
45	1,1,1-Trichloroethane	200	2000
46	1,1,2-Trichloroethane	2000	2000
47	Trichloroethene	2000	2000
48	Trichloromonofluoromethane	200	2000
49	1,2,3-Trichloropropane	500	5000

TABLE 6-2A: K019 WASTE BDAT LIST CONSTITUENT DETECTION LIMITS (VOLATILES)

BDAT CONSTITUENT		DETECTION LIMIT ** SAMPLE SET #1	DETECTION LIMIT ** SAMPLE SETS #2 THROUGH #6
50	Vinyl chloride	200	2000
79	3-Chloropropionitrile +	NA	NA
*	Acetone	1000	10000
*	Allyl alcohol	NA	NA
*	Ethyl benzene	200	2000
*	Ethylene oxide	NA	NA
*	2-Hexanone	1000	10000
*	Malononitrile	NA	NA
*	4-Methyl-2-pentanone	1000	10000
*	2-Propyn-1-ol	NA	NA
*	Styrene	200	2000
*	Trichloromethanethiol	NA	NA
*	Vinyl acetate	200	2000
*	Xylene (total)	200	2000

NA The standard is not available; the compound was searched using an NBS library database of 42,000 compounds.

* This constituent is not on the list of constituents in the GENERIC QUALITY ASSURANCE PROJECT PLAN FOR LAND DISPOSAL RESTRICTIONS PROGRAM ("BDAT"), EPA/530-SW-87-011, March 1987. It is a ground-water monitoring constituent as listed in Appendix IX, Page 26639, of the FEDERAL REGISTER, Vol. 51, No. 142.

** Sample set #1 was diluted by a factor of ten, analyzed, and quantitated. Even at this dilution, several target analytes were outside the calibration range. These analytes were quantitated after reanalysis of the sample at a dilution factor of 100. The detection limits for sample set #1 are based on the ten factor dilution. Because sample set #2 through #6 were similar matrices to that of sample set #1, they were diluted by a factor of 100 before any analyses were performed.

+ The compound appears in the GENERIC QUALITY ASSURANCE PROJECT PLAN as a semivolatile constituent but was analyzed as a volatile constituent.

TABLE 6-28: K019 WASTE BDAT LIST CONSTITUENT DETECTION LIMITS (NON-VOLATILES)

BDAT CONSTITUENT	DETECTION LIMIT
SEMIVOLATILE CONSTITUENTS:	[ppm]
38 Methyl methanesulfonate +	50
39 Pyridine +	100
51 Acenaphthalene	10
52 Acenaphthene	10
53 Acetophenone	10
54 2-Acetylaminofluorene	NA
55 4-Aminobiphenyl	10
56 Aniline	25
57 Anthracene	10
58 Aramite	NA
59 Benz(a)anthracene	10
60 Benzenethiol	NA
61 Benzidine	10
62 Benzo(a)pyrene	10
63 Benzo(b)fluoranthene	NA
64 Benzo(g,h,i)perylene	25
65 Benzo(k)fluoranthene	10
66 p-Benzoquinone	NA
67 Bis(2-chloroethoxy)ethane	10
68 Bis(2-chloroethyl)ether	10
69 Bis(2-chloroisopropyl)ether	10
70 Bis(2-ethylhexyl)phthalate	10
71 4-Bromophenyl phenyl ether	50
72 Butyl benzyl phthalate	10
73 2-sec-Butyl-4,6-dinitrophenol	NA
74 p-Chloroaniline	25
75 Chlorobenzilate	NA
76 p-Chloro-m-cresol	25
77 2-Chloronaphthalene	10
78 2-Chlorophenol	10
80 Chrysene	NA
81 ortho-Cresol	10
82 para-Cresol	10
83 Dibenz(a,h)anthracene	10
84 Dibenzo(a,e)pyrene	NA
85 Dibenzo(a,i)pyrene	NA
86 m-Dichlorobenzene	10
87 o-Dichlorobenzene	10
88 p-Dichlorobenzene	10
89 3,3'-Dichlorobenzidine	50
90 2,4-Dichlorophenol	25
91 2,6-Dichlorophenol	25
92 Diethyl phthalate	10
93 3,3'-Dimethoxybenzidine	50
94 p-Dimethylaminoazobenzene	25
95 3,3'-Dimethylbenzidine	NA
96 2,4-Dimethylphenol	25
97 Dimethyl phthalate	10
98 Di-n-butyl phthalate	10
99 1,4-Dinitrobenzene	50
100 4,6-Dinitro-o-cresol	250
101 2,4-Dinitrophenol	250
102 2,4-Dinitrotoluene	250
103 2,6-Dinitrotoluene	50
104 Di-n-octyl phthalate	10
105 Di-n-propylnitrosamine	25
106 Diphenylamine	10
107 1,2-Diphenylhydrazine	10
108 Fluoranthene	10
109 Fluorene	10
110 Hexachlorobenzene	50
111 Hexachlorobutadiene	50
112 Hexachlorocyclopentadiene	50
113 Hexachloroethane	50
114 Hexachlorophene	NA
115 Hexachloropropene	50
116 Indeno(1,2,3-cd)pyrene	10
117 Isosafrole	NA
118 Methapyrilene	NA
119 3-Methylcholanthrene	NA
120 4,4'-Methylenebis(2-chloroaniline)	NA
121 Naphthalene	10
122 1,4-Naphthoquinone	10
123 1-Naphthylamine	10
124 2-Naphthylamine	10
125 p-Nitroaniline	50
126 Nitrobenzene	25
127 4-Nitrophenol	50
128 N-Nitrosodi-n-butylamine	25
129 N-Nitrosodiethylamine	50
130 N-Nitrosodimethylamine	100
131 N-Nitrosomethylethylamine	NA
132 N-Nitrosomorpholine	50
133 N-Nitrosopiperidine	50
134 N-Nitrosopyrrolidine	50
135 5-Nitro-o-toluidine	NA
136 Pentachlorobenzene	50
137 Pentachloroethane	50
138 Pentachloronitrobenzene	50
139 Pentachlorophenol	250
140 Phenacetin	10
141 Phenanthrene	10
142 Phenol	10
143 2-Picoline	100

TABLE 6-28: K019 WASTE BOAT LIST CONSTITUENT DETECTION LIMITS (NON-VOLATILES)

	BOAT CONSTITUENT	DETECTION LIMIT		BOAT CONSTITUENT	DETECTION LIMIT
	SEMIVOLATILES (CONTINUED):	(ppm)		METALS:	(ppm)
144	Pronamide	50	154	Antimony	6
145	Pyrene	10	155	Arsenic	0.2
146	Resorcinol	NA	156	Barium	0.9
147	Safrole	NA	157	Beryllium	0.1
148	1,2,4,5-Tetrachlorobenzene	25	158	Cadmium	0.3
149	2,3,4,6-Tetrachlorophenol	50	159	Chromium	0.9
150	1,2,4-Trichlorobenzene	25	159	Chromium, hexavalent	0.2
151	2,4,5-Trichlorophenol	50	160	Copper	1
152	2,4,6-Trichlorophenol	50	161	Lead	0.2
153	Tris(2,3-dibromopropyl) phosphate	NA	162	Mercury	0.05
*	7,12-Dimethylbenz(a)anthracene	25	163	Nickel	2
*	alph,alpha-Dimethylphenethylamine	50	164	Selenium	0.5
*	Benzoic acid	250	165	Silver	0.9
*	Benzyl alcohol	25	166	Thallium	0.2
*	4-Chlorophenyl phenyl ether	25	167	Vanadium	2
*	Dibenzofuran	10	168	Zinc	0.6
*	Dibenzo(a,h)pyrene	NA			
*	Isophorone	10		OTHER CONSTITUENTS:	
*	2-Methylnaphthalene	10			
*	2-Nitroaniline	50	169	Total Cyanide (ppm)	0.5
*	3-Nitroaniline	50	170	Fluoride (ppm)	5
*	2-Nitrophenol	50	171	Sulfide (ppm)	50
*	N-Nitrosodiphenylamine	10		Chlorine (%)	0.3
				PHYSICAL PARAMETERS:	
				Ash Content (%)	0.01
				Heating Value (Btu/lb)	100
				Total Solids (% residual)	0.05
				Paint Filter Test (% free liquid)	0.5

NA The standard is not available; the compound was searched using an NBS library database of 42,000 compounds.

* This constituent is not on the list of constituents in the GENERIC QUALITY ASSURANCE PROJECT PLAN FOR LAND DISPOSAL RESTRICTIONS PROGRAM ("BOAT"), EPA/530-SW-87-011, March 1987. It is a ground-water monitoring constituent as listed in Appendix IX, Page 28839, of the FEDERAL REGISTER, Vol. 51, No. 142.

+ The compound appears in the GENERIC QUALITY ASSURANCE PROJECT PLAN as a volatile constituent but was analyzed as a semivolatile constituent.